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AGRICULTURAL ECONOMICS RESEARCH

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AGRICULTURAL ECONOMICS RESEARCH

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The Survey As A Measurement Instrument

By Earl E. Houseman

Cost-benefit ratios for surveys are related to the congruence between objectives and survey measurement capabilities. A high degree of congruence requires careful matching of objectives and survey design. Thus, emphasis is placed on survey planning and improvement of relationships between survey designs and objectives. The degree of congruence has a significant effect on the efficiency of research and the interpretations and value of results.

Key words: Survey techniques; survey planning; probability sampling; statistical inference; evaluating survey data; congruence.

There should be better communication between agricultural economists as users and survey statisticians as producers of statistical information. Owing to differences in training, duties, and philosophic principles, they have different perspectives. Both could benefit from freer exchange of views in the interest of improving surveys as measurement instruments for various purposes. Admittedly, many of the remarks in this article are impressions and hypotheses emerging from years of experience as a sampling statistician and consultant. I hope some of the items or points of view that are presented will be helpful to social scientists and will suggest some avenues for exploration. I also hope that this article will contribute to better understanding and cooperation between social scientists and survey statisticians.

Introduction

The survey is used to measure numerous kinds of characteristics or quantities pertaining to a wide variety of populations. We have much commonsense understanding of the capability of various physical measurement devices and we appreciate the need to choose an instrument that is suitable for the purpose. For example, it might be important to find out whether the difference in diameters of two automobile pistons, machined to the same specifications, is less than some specified amount. Would you use an ordinary yardstick? The incongruence between the objective and the measurement tool is obvious. When surveys are involved, congruity between objectives and errors of measurement is often obscure depending upon intelligence about the capability of the survey. A major purpose of the science of survey technology is enabling better judgment in the development of survey plans in relation to objectives.

With reference to planning research, Cox[1] in 1951 stated: "The statistician who expects that his contribution to the planning will involve statistical theory, finds repeatedly that he makes his most valuable contribution simply by getting the investigator to explain why he is doing the experiment, to justify the experimental treatments and to defend his claim that the experiment, when completed, will enable its objectives to be realized." "Survey" may be substituted for experiment. Cox's statement contains a message for social scientists who are planning surveys and for professional survey statisticians. The writer's general experience is in accord with Cox's observation.

The experienced applied mathematical statistician is a student of variability (measurement error). He is a statistical engineer. A major part of his business is to understand variability and to know how to cope with it effectively. With experience he acquires an unusual insight of patterns and magnitudes of variability that commonly exist in the world we live in. He develops good judgment of the efficiency of alternative survey designs in relation to objectives. In most cases, he can provide good indications of what the precision (and to some extent the accuracy) of the results will be. In survey planning, this kind of expertise is one of the essential inputs to achieving a high degree of congruence (or a good match) between objectives and the measurement instrument.

With reference to measurement problems, it is possible to draw many analogies between the physical and social sciences. The quantities to be measured need

[1] Gertrude M. Cox, The Value and Usefulness of Statistics in Research. A lecture presented in the Department of Agriculture Auditorium, January 11, 1951.

to be defined or specified. The physical measurement instrument and the measurement "instrument" for a survey (namely the sample including the questionnaire, etc.) have similar roles. Skills and procedures involved in using measurement instruments have a bearing on the accuracy of the results. Errors of measurement, both constant (bias) and variable (random), always exist to some degree in either case. We have heard about calibration of physical measurement instruments. Surveys also need "calibration." However, the main point under consideration is the matter of achieving good congruity between objectives and the measurement instruments.

The writer is unable to state an exact definition of congruity; but it is clear that the cost-benefit ratio for a survey is related to the degree of congruence between objectives and the measurement capability of the survey. Degree of congruence is a major factor affecting efficiency of research, interpretation and value of results, and rate of progress. Hence, a good understanding of what is involved in good congruity and how to achieve it is needed.

Planners of surveys agree that a survey should make a contribution to knowledge, but they have widely varying views as to the kind of a survey that is appropriate for a particular purpose. A major responsibility of the statistician is to be as expert as possible regarding the capability of a survey as a measurement instrument and the best way to fashion it to assure success with reference to a particular set of objectives. In practice, cooperative team effort is usually needed to obtain congruity of objectives, design, and resources in the interest of achieving the most favorable cost-benefit ratio.

Perhaps some readers of this article are unfamiliar with the technical meaning of "precision" and "accuracy" as words describing properties of an estimate, so let's review the concepts briefly:

Precision of an estimate is measured in terms of its standard error, which is a measure of random variation of an estimate from its "expected" value. The expected value of an estimate might differ from the "target" value. The differences between the expected and target values is bias, or a constant component of error that is not measured by the standard error.

Accuracy is a measure of the total error of an estimate. It pertains to the possible deviations of an estimate from the target value and is a combination of the standard error and bias.

The use of the words "precision" and "accuracy" in statistics is analogous to their use in the physical sciences. One may speak of a precision instrument in a laboratory, meaning that the instrument is capable of making very exact measurements or detecting very small differences. But the readings will not necessarily be accurate unless the instrument is correctly calibrated and is functioning properly. An accurate instrument must be relatively free of bias as well as precise. A clock, for example, that is always exactly 10 minutes fast is precise but inaccurate. A sample may provide an estimate that is precise (low standard error), but high precision alone does not mean that the estimate is accurate. Note that, although we commonly speak of the "accuracy of an estimate," statements of accuracy or precision reflect attributes of the entire system that generates an estimate. System refers to the whole survey process; that is, sample design, editing specifications, method of estimation, the way questions are asked, etc.

Some Examples Involving Congruity

Can we agree that an estimate is of undetermined value and hence of no value when we have absolutely no knowledge whatever (not even subjective experience) about its accuracy? That is, the utility of an estimate is a function of the nature and amount of information we have about its accuracy, which depends upon the measurement instrument and the care with which it is used. Here are some examples that illustrate a few aspects of the congruity problem:

1. A survey was proposed to get a measure of an average cost per unit. The sample was rather small. Discussion revealed that the average cost was already known within about 10 or 15 percent. The survey was proposed because a much more accurate answer was needed, but the proposed survey design and sample size were such that the prospects were not favorable for getting better information. If the survey had gone forward on this basis, an answer that "looked" all right, or a "satisfying" result, might have been obtained. But how does one judge the accuracy of an estimate? This is a key point in achieving congruity. It is a question involving many facets of survey technology and hence a subject outside of the scope of this article.

Fortunately, with regard to the case just mentioned, it was possible to revamp data specification and analysis plans so there would be a direct tie with data that already existed for each unit in the population. This meant that the objective of acquiring an accurate estimate of the average unit cost could be fulfilled by adopting a more efficient design without increasing the sample size. Thus, when knowledge of the

measurement capability of the proposal was brought into consideration, a different view of the job was formulated and a measurement device was fashioned which would more closely meet the objectives. Frequently, in a case of this type, objectives must be curtailed or resources increased to achieve congruity.

Usually, the more that is known about the subject under investigation, the more complex and stringent the survey requirements become. So the task of planning (that is, adjusting objectives, design, and resources) can be a major undertaking—but an undertaking that is necessary to avoid fruitless effort or inefficient expenditure of resources. There have been cases where an investigator repeated essentially the same survey several times trying to get better answers to an important problem. Typically, the first survey or two contributed an appreciable amount of information. But, from there on, the additional surveys added very little because the efforts were the equivalent of trying to get a better measurement of the same quantity with the same yardstick. There are many variations of this type of situation—the general picture being that as information about a subject is acquired, the survey as a measurement instrument remains essentially unchanged and the returns from the efforts diminish. In this type of situation, congruity diminishes because improved measurement instruments are not employed to meet the more exact requirements that develop. In the allocation of funds for specific projects too much weight is often given to the importance of the problem and not enough to the prospects for a good return from the investment.

2. Let us look briefly at another type of case—one where the congruity was very good but the capability of the measurement instrument was not adequately understood. An investigator had worked very closely with a statistician on the design of an experiment to determine which of two methods of transportation had the lesser detrimental impact on the quality of a product. The design of the experiment was excellent and it was conducted with unusual care. The observed difference between the two methods was not statistically significant—a disappointing result because the investigator firmly believed that a difference between the two methods existed. The investigator returned to the statistician for advice on the number of additional replications that might be needed to achieve statistical significance. He had overlooked one important point; the experimental error was less than one-half of 1 percent. Thorough checking showed that the analysis and arithmetic were without error. Discussion between the investigator and the statistician led to a conclusion that the experiment was accurate enough to detect any difference between the two methods that was large enough to be of practical importance. Hence, at this decision point, the question of additional replication shifted to a question of whether to continue the work under another set of experimental conditions. Note how knowledge of the error associated with the measurement instrument influenced the interpretation of results, and changed the research objectives.

3. Knowledge of variance components can have a bearing on the effectiveness of research. For example, a research group was trying to develop better physical devices for sampling and estimating the quality (grade) of an agricultural product stored in bulk. It happened, owing to the group's lack of knowledge about various components of variance, that the research efforts were *not* oriented to reducing the one component of variance that was much greater than any other. After some fruitless effort, an analysis of variance pointed the direction for more productive research.

4. It is common for an investigator to propose a project wherein there is doubt about whether some of the objectives can be met. But let's consider those cases where even the key objectives are in such conflict with the capabilities of the proposed measurement instrument that the prospects for success are nil. When an investigator receives comments to that effect, one of two kinds of reaction is likely to be elicited. Some investigators are anxious to correct the situation and to reach common understanding about congruity. This type of investigator will usually have resolved matters of congruity between objectives and survey plans before arriving at a final proposal.

The other kind of reaction tends to be defensive. The investigator will explain the great importance of the survey, and the extent of the backing, as though the urgency were so overwhelming as to justify any survey tool. In this case, the investigator's own statements are sometimes incongruous. If the problem is of the great importance portrayed, then planning a survey that will do a satisfactory measurement job is also important. The time-worn argument that "a little information is better than none" is often used. It appears that some investigators haven't recognized that an estimate with low accuracy might have a negative value, or add little or nothing to what is already known. Please ponder the question: "What constitutes new or additional information?" As a minimum, one should try to plan a survey so there is a reasonable chance that it will make a positive contribution.

5. Sometimes the objectives of a particular project are limited more than necessary. To illustrate, let's assume a national survey of 20,000 households. A typical survey plan might call for allocating the sample

about equally to four regions to accommodate regional as well as national tabulations. Is this the best use of available resources? For example, it might be feasible to divide the total sample of 20,000 in the time dimension to provide temporal as well as spatial comparisons. Much depends upon the kind of items involved and the nature of the problem. For some purposes, it is possible that regional comparisons involving an average of four points in time might be more useful than comparisons for one point. Secondly, a sample of 5,000 for each time period could be designed so that regional comparisons for all periods combined would have essentially the same sampling errors as a single sample of 20,000 at one time.

Thus, changing plans to provide temporal comparisons doesn't necessarily mean sacrificing accuracy of regional comparisons. Even though each time period is represented by an independent sample of 5,000, the sampling errors for time comparisons (depending on the kind of items measured) could be about the same as, or substantially less than, the sampling errors for regional comparisons. The cost of a 20,000-household sample survey conducted at one time would be less than the cost of surveying 5,000 at four points in time. But the example illustrates that, in planning, interplay between objectives and survey plans is needed. The importance of insight regarding possible alternatives in relation to objectives and cost is obvious.

Numerous additional illustrations could be cited to emphasize the value of knowing as much as possible about components of error, the capability of a survey, and the best way to design a survey for a complex set of objectives. Knowing how to approach a problem is of major importance. It helps to have a good perspective of various aspects of planning and to resolve a problem into a logical framework. For example, data specification problems are often construed as sampling problems. In that case, it might help to think in terms of the data and analytical specifications that would be appropriate if all units in the population were to be included in the survey. This can help resolve definitions of population parameters to be estimated, as well as data specifications pertaining to individual units of observation. When the planning has reached this point, one is in a good position to resolve matters of the sample design and the questionnaire, but throughout the planning process the idea of achieving congruity should stand out. After the objectives and the survey plans are in congruity, the survey technicians are free to follow through with details of sample design and selection as well as questionnaire structure and content.

Assurance that congruity is good requires a clear common understanding of analytical plans which, under the time pressures involved, are too often overlooked. Incidentially, in the writer's view, objectives have not been fully specified until tabulation plans, at least in broad outline, have been formulated. There have been many cases where important omissions in a questionnaire have occurred because analysis plans had not received adequate attention before the questionnaire was put in final form.

Usually, out of a broad or general set of objectives a few key objectives can be identified which *must* be achieved with some recognizable degree of accuracy. These key objectives receive most of the weight in setting sample design and size specifications. Lesser objectives are then accommodated to the extent feasible. In other words, usually one does not anticipate complete fulfillment of objectives, so the main strategy is to seek assurance that key objectives are satisfied.

Unfortunately, the amount of lead time for planning surveys usually leaves much to be desired. Be aware that the pressures of time often call for very good planning rather than going forward with something that is "half-baked." It is possible that a little extra time spent on careful planning could reduce the lapse of time between inception and completion. In other words, planning that clarifies procedures, cuts processes to essentials, and foresees and eliminates potential delaying snags might speed up the whole job as well as provide a higher quality product. Although the pressures of time might reduce the opportunity for thorough planning, time pressure should not become an excuse for poor planning.

Because the approach to applying probability sampling stresses definitions of parameters and level of accuracy needed, much progress has been made toward better congruity since probability sampling became generally accepted. We are beginning to acquire a broad basis for evaluating and improving the returns from investments in statistical programs. We should give more attention to the whole problem of inference, using a cooperative approach among the disciplines involved.

Inference—A Bridge With Two Spans

The writer has a general concept of the problem of making inferences which he has found helpful in approaching many problems and in responding to questions about inference. The inference bridge may be

thought of as consisting of a statistical span and a nonstatistical span. Statistical inference refers to an inference that is founded in probability theory; for example, an inference made from a probability sample about the population from which it was drawn. No attempt is being made to be rigorous. For present purposes, the key point of distinction between the two inference spans is that (1) the nonstatistical span refers to inference that extends beyond the specific population parameters that estimates pertain to, and (2) the statistical span refers to inference from sample data to the population which the sample represents.

Survey objectives and designs involve both spans to some degree. Sometimes there is a tradeoff between (1) making the statistical span short and strong and the nonstatistical span long and weak, or (2) making the statistical span longer (and perhaps weaker) so the nonstatistical span will be shorter. Which inference bridge is best? The whole inference bridge should be kept in mind when planning surveys and stating conclusions from survey results.

Incidentally, from several points of view including inference, censuses and samples are alike. A census may be viewed simply as a large sample. In either, the problems of what to measure, how to measure, and what to infer are essentially the same. Statisticians measure the accuracy of an estimate with reference to its sampling distribution. In a very real sense, results from a census are also estimates and conceptually have an error distribution equivalent to a sampling distribution. Hence, "survey" may include censuses as well as samples.

A nonstatistical inference span always exists. In many instances, there is no statistical span, depending upon how the statistical span is defined. Although one might be able to limit interpretations of data strictly to the population involved, the nonstatistical span exists because action inference decisions, beyond the population to which data relate, are inescapable. There are numerous reasons for this, but one ever-present reasons is the simple fact that the passing of time never ceases; so, to some degree, actions always relate to something that differs from what the data represent. Also, owing to the incomplete nature of information, action decisions generally involve considerations other than information contained in estimates. Hence, there is uncertainty associated with a decision even if all estimates bearing on the decision are without error.

Users of data are generally concerned about the accuracy of data with which they are working. One should be equally concerned, perhaps even more concerned, about the relevance of the data to decision problems. In the writer's view, relevance of an estimate refers to its potential contribution to a decision when there is no error in the estimate. An investment that reduces the sampling error of an estimate provides no return unless the estimate is relevant. We need to know more about how the level of accuracy that is worth purchasing is related to degree of relevance and to what is at stake in the decisions or actions.

Users of data want to be able to make good decisions. They want "reliable" estimates. Assuming the word reliable refers to something that can be counted upon to do whatever is required or expected, a reliable estimate must be accurate and relevant. Hence, degree of reliability might be considered a function of accuracy and relevance. Reliability is sometimes unwittingly equated only with accuracy. We need to give much more attention to evaluating the tradeoff between accuracy of estimates and filling data gaps or doing other things that will strengthen the inference bridge, such as developing improved analytical or decision models.

As the accuracy of a relevant estimate (or set of estimates) is improved, the statistical span of the inference bridge is improved. But it seems intuitively clear that a point is reached where the nonstatistical span becomes comparatively weak and where additional accuracy of estimates will contribute practically nothing to improving the inference bridge. This point is especially important in light of the fact that the marginal cost of additional increments of accuracy increases at a rapid rate. Also, it seems clear, intuitively, that the marginal value of an estimate diminishes as the error becomes very small. Hence, as investments for higher and higher levels of accuracy are considered, a question that becomes increasingly critical is, "How much is any given level of accuracy in an estimate worth?"

It is important to recognize accuracy as a function of two major components—random error (standard error) and bias. The relationship of bias and of standard error to the value of an estimate might be very different; in addition, survey methods and costs differ with regard to reducing standard error and to reducing bias. (Incidentally, the reader should have in mind the quite general situation that as sample size is increased, the standard error of an estimate might become small relative to bias in the estimate.) To illustrate the point about bias versus standard error, consider a time series. The value of the estimates in the series might be increased by a large amount if the standard error were reduced from, for example, 3 percent to 1 percent. But suppose there is an unknown bias of 2 percent in all estimates in the series. If this bias were discovered and reduced, how much, if any,

would the value of the series be improved? That type of question has been, and will probably continue to be, debated for decades. However, the writer is simply trying to point out that in his view the value of an estimate, as a minimum and to the extent possible, should be treated as a function of relevance, standard error, and bias. This suggests that some econometric model builders should attempt to separate the contribution of an estimate (a variable in the model) with regard to relevance, standard error, and bias. This type of information could provide very valuable guidance in building and directing statistical programs.

Figure 1 depicts relationships of value and cost of an estimate to standard error of the estimate. Bias is assumed to be negligible at least in terms of effect on the value of the estimate. Much is known about the relationship between cost and sampling error, whereas the relationship between value and sampling error is a matter of conjecture. In figure 1, the maximum point, A, of the benefit curve corresponds to "relevance" of the estimate as discussed earlier. It is conceivable that the maximum for some variables could be negative, because a completely irrelevant variable in a model or decision situation could make a negative contribution even though it contained no error whatever.

With reference to figure 1, proposed surveys need careful examination for possible improvement of the benefit-cost ratio when the sampling standard errors for key items are less than B or greater than C, where B and C are arbitrary amounts. If the sampling errors are greater than C, usually additional resources are called for to increase sample size although adjustments in objectives or survey plans can sometimes be made to improve the cost-benefit ratio without additional cost. If the proposed plans indicate sampling errors that are lower than B, some appropriate actions that might be taken are:

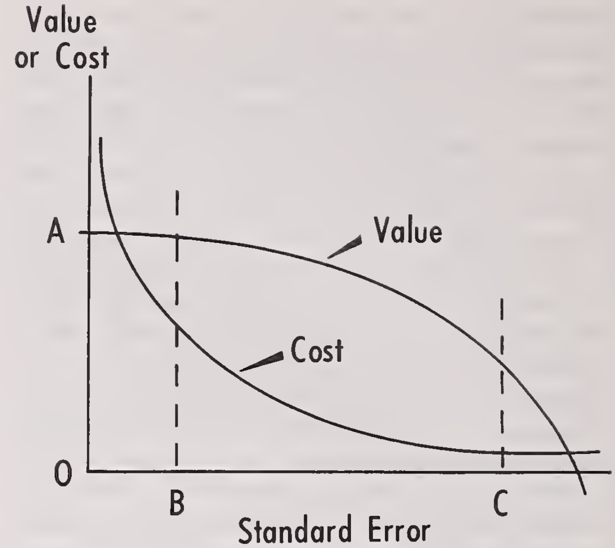

Figure 1.—Value and cost of estimate as functions of standard error.

(1) Broaden the objectives;

(2) Reduce sample size and invest the savings in another project; or

(3) Reduce sample size and invest savings in efforts to reduce bias if appreciable biases are likely to exist.

Perhaps, as knowledge about the value curve is acquired, a criterion for determining the optimal level of standard error will emerge—namely, finding the point where the vertical distance between the value curve and the cost curve is maximized.

Linear Approximations of Nonlinear Relationships by the Taylor's Series Expansion Revisited

By Abner W. Womack and Jim L. Matthews

This paper examines the magnitude of error associated with linear approximations of nonlinear variables based on Taylor's Series. Little attention has been given to the error term in previous empirical studies. This paper presents the mathematical technique for the single-variable and two-variable cases. Examples are given for each situation using agricultural time-series data. Characteristics of time-series data are sometimes crucial in the selection of an evaluation point for minimum error. The importance of selecting evaluation points is illustrated for three categories of time-series data: (1) smooth trends, (2) trends with substantial variation, and (3) oscillatory series.

Key words: Mathematical analysis; nonlinear; methodology; time-series analysis; statistics; research methodology.

Nonlinear functions are commonly used in econometric analyses because of either theoretical or statistical considerations in choosing the form of the equation. As a rule, this poses no serious difficulty to the analyst. However, nonlinear specification of relationships is difficult to manage, particularly where those relations appear in a sub-block of simultaneous equations that contain linear market-clearing identities. What is frequently desired in any simultaneous equilibrium model specification is to reexpress the structural equations in terms of their reduced form equivalents. This is often difficult to do for a nonlinear system.

To achieve a solution without undue mathematical complexity, one approach suggested by Klein is to obtain linear approximations of all nonlinear endogenous variables in the system by a Taylor's Series expansion (*8*).[1] This technique was used by Gerra for a poultry model and more recently by Houck and Subotnik in a simultaneous model for the U.S. soybean economy (*5*, *7*). Several studies have employed Taylor's Series for purposes other than a linearization tool. Edwards demonstrated that linear estimation schemes could be applied to nonlinear equations iteratively in deriving B.L.U.E. estimators as well as in solving nonlinear programming problems (*3*). Burt, in 1968, applied the Taylor's Series expansion to a nonlinear identity equation ($y=x \cdot z$) to illustrate the component variances of a variable y associated with two separate random variables that appear as a product, namely, $x \cdot z$ (*2*).

[1] Italic numbers in parentheses refer to Bibliography, p. 101.

Though the Taylor's Series is well documented in most calculus texts or texts on mathematics for economists, relatively little attention has been given to its accuracy as a linearization technique for several commonly used nonlinear variables in econometric analyses (*1*, *9*).

This paper examines the accuracy and use of Taylor's Series expansions for several types of nonlinear variables commonly used in econometric analyses. Refinements in the technique are considered for several combinations of characteristics of data series for the variables linearized.

The first section gives Taylor's Theorem with a discussion of the remainder term for the linear case. The second section of the paper shows a linear approximation relation for the single-variable case, namely $\log_{10} x$. Refinements in the use of the relation are shown for two sets of sample observations taken from actual agricultural time-series data. The third section of the paper shows the linear approximations for products and ratios of variables. As in the preceding section, agricultural time-series data with markedly different sample data properties with respect to variance and trend are used to demonstrate the linear accuracy of the technique about different evaluation points, depending on the characteristic of the data series for the variable.

Taylor's Theorem

The polynomial approximation form of Taylor's Series for the single variable case is stated as:

(1) $f(x) = f(a) + f'(a)(x-a) + f''(a)(x-a)^2/2!$

$$+ f'''(a)(x-a)^3/3! + \ldots + f^n(a)(x-a)^n/n! + R_n$$

where

$$R_n = f^{n+1}[a + \phi(x-a)]\,[x-a]^{n+1}/(n+1)!$$

for $0 < \phi < 1$, $x \neq a$, n a positive integer, and f a function whose nth derivative $f^{(n)}(x)$ exists for each number between x and a.

From (1) for $n = 1$ we have a linear relationship:

(2) $R_1 = f(x) - f(a) - f'(a)(x-a)$.

As indicated in (2), $R_1 \to 0$ as $x \to a$. Hence the evaluation point (a) for a particular linear approximation should be chosen such that R_1 is small. If R_1 is small, the nonlinear function $f(x)$ is approximated by the linear function $f(a) + f'(a)(x-a)$. As is often the case, the mean of a series is chosen as the point for evaluation. The next section demonstrates that the selection of the evaluation point (a) depends on the nature of the series in question and may call for a point different from the mean for a minimum R_1.

The Single-Variable Case

Though several types of nonlinear expressions for a single variable x are commonly used, most can be readily transformed to $\log_{10}x$. For this reason this section is limited to a discussion of linear approximations of $\log_{10}x$.

For the function $f(x) = \log_{10}x$, formula (1) can be used to derive a linear estimate of $\log_{10}x$ for any of the n observations for x evaluated about some selected point (a).

The linear approximation equation is expressed in general as follows:

(3) $\mathrm{Log}_{10}x = (\log_{10}a - 0.4343) + 0.4343x/a$.

Examination of (3) shows that when $x = a$, $\log_{10}x$ is exactly equal to $\log_{10}a$. Linear approximations of x evaluated at or near (a) will result in a good linear approximation of $\log_{10}x$.

In applying formula (3) to a given data series, selection of an evaluation point (a) is quite important if a high degree of accuracy is to be achieved. For convenience, evaluation of x about $a = \bar{x}$ may be considered. This choice of an evaluation point may not be a bad one if the data series is relatively smooth with no significant trends. However, irregular data series with or without trends may require evaluation about some point other than $a = \bar{x}$. An alternative is to use a series of choices such as the previous value of x or some moving average of recent observations on x. These series are not as convenient to use as a single point because of the required iteration routines but may be warranted if a high degree of linear accuracy in estimating x is desired.

To demonstrate some of the options open to the analyst, figures 1 to 3 show linear approximations of $\log_{10}x$ for three alternative evaluation points where x is soybeans under loan (million bushels) for the period 1954 to 1968. The series is irregular with only a slight upward trend. As shown in figure 1, evaluation about the mean ($a = \bar{x}$) is reasonably good. Largest inaccuracy occurs at the end points of the series or points furthest from the mean. An attempt to correct for this inaccuracy is shown in figures 2 and 3. In figure 3, use of the previous period value reduced the inaccuracy at the end points but magnified the errors when sharp year-to-year variations occurred. In figure 2, use of a 2-year moving average improved the fit when compared to figure 3 but was less desirable than figure 1. Longer moving averages would improve the fit in figure 2.

Based on this example, two inferences which can be drawn are: (1) for irregular series with no trend, evaluation about $a = \bar{x}$ would be the best choice, and (2) for irregular series with trend, a moving average of previous values of x should be used.

Another situation quite common in economic analysis is shown in figure 4. The series for $\log_{10}x$ is smooth with a definite trend. Evaluation about a fixed point (a = value of x in 1954) shows that substantial bias in the linear approximation of per capita disposable income in 1968 would have occurred. Use of the previous period observation on x in this situation results in a very close linear approximation. Thus, it is recommended that $a = x_{-1}$ be used for data series that are smooth with marked trends for obtaining linear approximation of x for the function $\log_{10}x$.

Products and Ratios of Variables

Linear approximations based on Taylor's Theorem for a single variable can be extended to two or more variable cases without any serious conceptual problems. Two or more variable cases commonly encountered by analysts are ratios and products of variables. This section is restricted to the two-variable case.

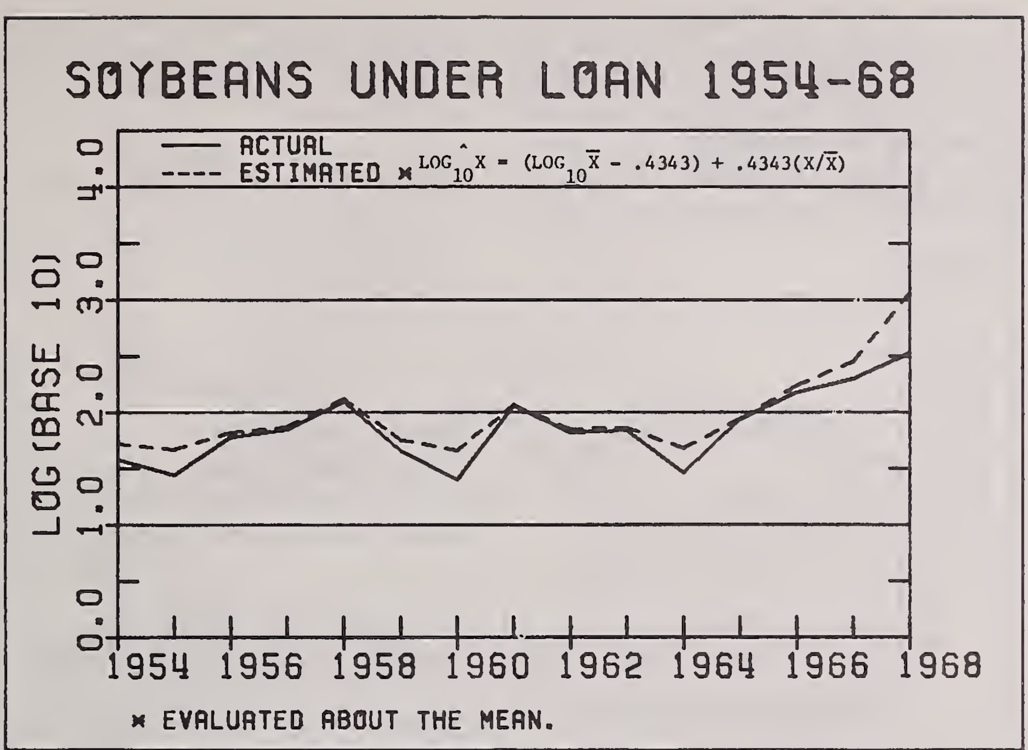

Figure 1

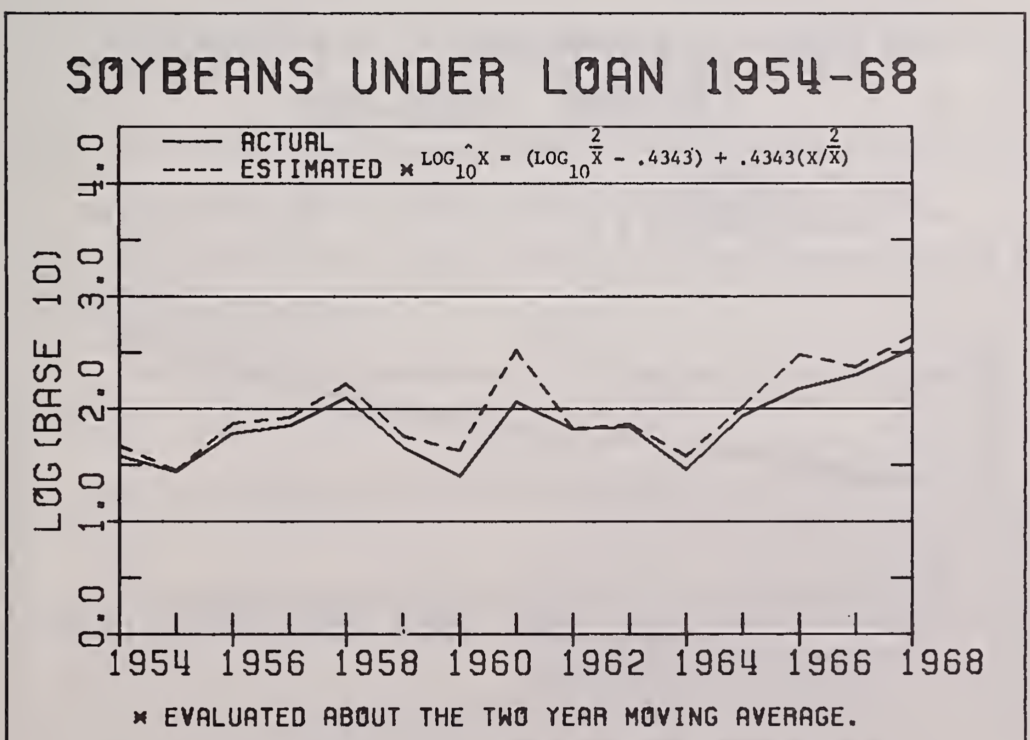

Figure 2

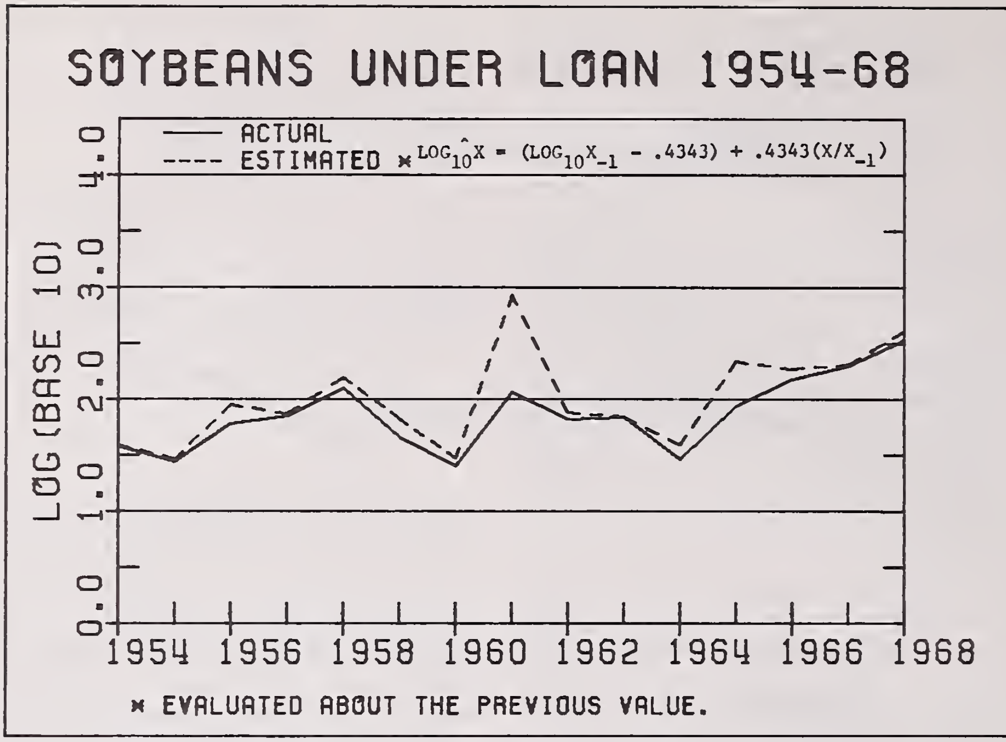

Figure 3

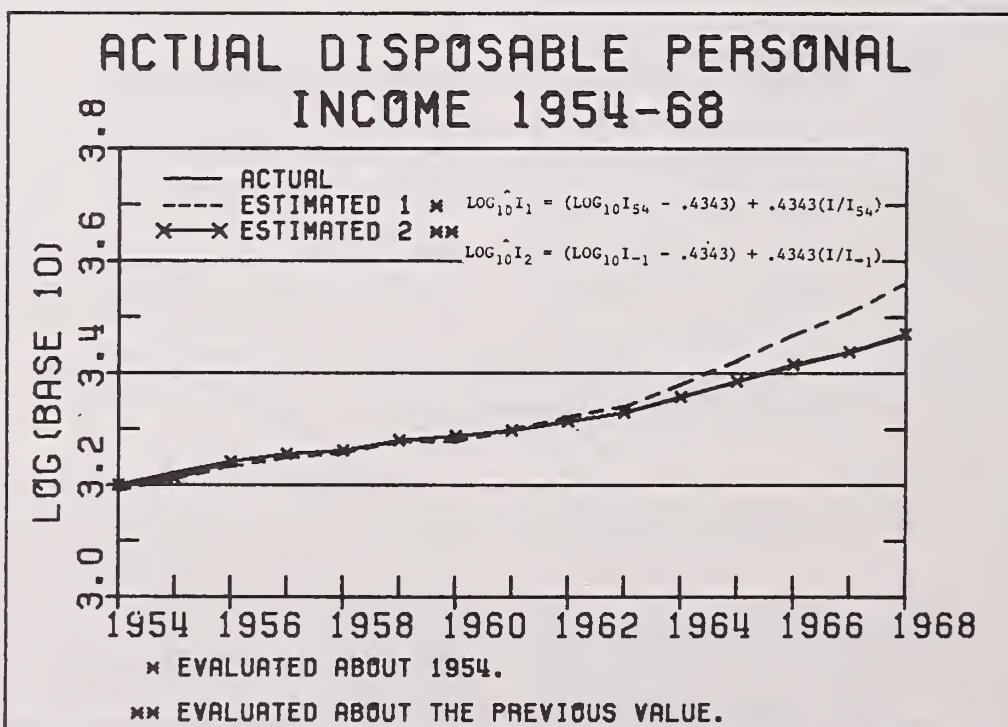

Figure 4

For the Taylor's Series expansion of a function F in two variables having continuous partial derivatives of the nth order, a relation comparable to (1) can be expressed as follows:

$$(4)\quad F(a+dx,\, b+dy) = F(a,b) + dF(a,b) + d^2F(a,b)/2! + \ldots + d^nF(a,b)/n! + R_n$$

where

$$R_n = d^{n+1}F(C,D)/(n+1)!$$

and C is between a and $a + dx$ and D is between b and $b + dy$. dx and dy are any designated number used for differentials of the first and second variables. In this case, $dx = (x-a)$ and $dy = (y-b)$. From differential calculus, it can be shown that

$$(5)\quad dF(x,y) = F'(x,y) = \frac{\partial F(x,y)}{\partial x}\, dx + \frac{\partial F(x,y)}{\partial x}\, dy$$

For convenience of notation, the above differentials in (4) may be written as:

$$(6)\quad dF(x,y) = F'_x dx + F'_y dy$$

$$(7)\quad d^2F(x,y) = F''(x,y) = F'[F'(x,y)]$$

$$= d\left[\frac{\partial F}{\partial x}\, dx + \frac{\partial F}{\partial y}\, dy\right]$$

where $F = F(x,y)$

$$= \partial/\partial x\left[\frac{\partial F}{\partial x}\, dx + \frac{\partial F}{\partial y}\, dy\right]$$

$$+ \partial/\partial y\left[\frac{\partial F}{\partial x}\, dx + \frac{\partial F}{\partial y}\, dy\right] dy$$

$$= \frac{\partial^2 F}{\partial x^2}(dx)^2 + \frac{\partial^2 F}{\partial x \partial y}(dx)(dy)$$

$$+ \frac{\partial^2 F}{\partial x \partial y}(dy)(dx) + \frac{\partial^2 F}{\partial y^2}(dy)^2$$

$$= \frac{\partial^2 F}{\partial x^2}(dx)^2 + \frac{2\partial^2 F}{\partial x \partial y}(dx)(dy)$$

$$+ \frac{\partial^2 F}{\partial y^2}(dy)^2 = F''_{x^2}(dx)^2$$

$$+ 2F''_{xy}(dx)(dy) + F''_{y^2}(dy)^2$$

This pattern suggests that higher order derivatives may be obtained by using the corresponding expansion of the binomial distribution, $(a+b)^n$, when n represents the nth derivative. For the purpose of linearization, higher order derivatives are not required and therefore are not given.

Based on relations (4) through (7), linear approximations can be readily derived for ratios and products of variables as follows:

$$(8)\quad F(x,y) = x/y = F(a+dx,\, b+dy)$$

where

$$dx = (x-a) \text{ and } dy = (y-b)$$

$$F'(x,y) = (1/y)dx - (x/y^2)dy$$

$$F''(x,y) = (0)(dx)^2 + 2(-1/y^2)(dx)(dy) + (2x/y^3)(dy)^2$$

.

.

.

$$F^n(x,y) = (-1)^{n-1}(n!/y^n)(dx)(dy)^{n-1} + (-1)^n(n!\cdot x/y^{n+1})(dy)^n$$

Evaluation of the previous terms about a and b results in the following expansion:

$$(9)\quad F(x,y) = a/b + (1/b)(x-b) - (a/b^2)(y-b) + [2(-1/b^2)(x-a)(y-b) + (2a/b^3)(y-b)^2]/2! + \ldots + R_n$$

where

$$R_n = \frac{(dy)^n}{D^{n+1}}\left[(-1)^n(dx) + \frac{(-1)^{n+1}C}{D}(dy)\right]$$

for C between a and $a + dx$ and D between b and $b + dy$.

As in the single-variable case in the previous section, $R_n \to 0$ as $n \to \infty$. Thus the expansion evaluated about a and b can be taken to any desired level of accuracy. Since linearization of $F(x,y)$ is the objective, then only the first two terms of (4) can be used. Thus the linear approximation of x/y is simply the first two terms of (9) simplified as follows:

$$(10)\quad x/y = a/b + (1/b)x - (a/b^2)y + R_n$$

or

$$x \hat{/} y = a/b + (1/b)x - (a/b^2)y$$

Linear approximations of the product of two variables is quite similar to the ratio of two variables so only the first two terms of the expansion will be given. By definition, $F(x,y) = x \cdot y$. Thus, the first two terms of the expansion are:

$$F(x,y) = x \cdot y$$

$$F'(x,y) = y \cdot dx + x \cdot dy$$

Evaluation of the above derivatives about (a,b) gives:

$$(11) \quad x \cdot y = F(x,y) = F(a+dx, b+dy)$$

where

$$dx = x-a \text{ and } dy = y-b$$

$$x \cdot y = F(a,b) + F'(a,b) + R_n$$

$$x \cdot y = a \cdot b + b \cdot x - a \cdot b + a \cdot y - a \cdot b + R_n$$

$$x \hat{\cdot} y = -a \cdot b + b \cdot x + a \cdot y$$

Use of the linear approximations given in (10) and (11) has been quite good for most applications encountered by the authors. However, these approximations are subject to the same type of biases as encountered for $\log_{10} x$. Note that when $a = x$ and $y = b$ in (10) and (11), both became exact identities. Thus, linear approximations for x and y contain only small error when the evaluation points a and b are near x and y.

For convenience, the means of the series for x and y are often used as fixed evaluation points. For example, Gerra, Houck, and Klein evaluated about the mean in deriving linear approximations for ratios of ratios of two variables. For many situations, this procedure would result in only a small amount of bias. However, as shown in figure 5, linear approximations about the means for per capita consumption of eggs based on an update of Gerra's 1958 egg study led to significant error in recent years. This bias or residual difference occurred because of the large downtrend in per capita egg consumption in the 1960's. Evaluation at some point other than the mean is indicated if a high degree of accuracy is desired. As indicated in figure 6, use of the previous period values ($a = x_{-1}$, $b = y_{-1}$) leads to a substantial improvement for a linear approximation of the ratio of egg consumption to civilian population. In contrast to the smooth trending data series on eggs, linear approximations of farm-to-retail price ratios for oranges were quite good over the sample period 1954 to 1968 when evaluated about the means of the price series. As is clear from figure 7, the price ratio series has irregular movements and no trend. Evaluation about last period values for retail and farm prices of oranges magnified the residual differences when sharp year-to-year changes occurred, as shown in figure 8. Experiments with products of two variables have resulted in similar observations on the appropriate choice of an evaluation point.

Based on the examples discussed for both the single-variable and two-variable cases, evaluation about the mean will give the best linear approximations for series which fluctuate but have little or no trend. For smooth data series which have significant trends, evaluation about the previous period value should be used to minimize residual error in the linear approximations. Finally, fluctuating series with a distinct trend will require a moving average of recent past observations to obtain the best linear approximations. The choice of the number of observations for the moving average will depend on the extent of fluctuation about the trend in the series.

The above statements should be qualified with respect to computational requirements if the mean of a series is not appropriate. In simultaneous equation systems containing some nonlinear variables, use of an evaluation point other than a fixed point substantially increases the computational requirements for solving the system. Use of the previous period value, for example, requires the matrix of endogenous coefficients to be inverted on each successive solution iteration since $b_i = f(x_{i-1}, y_{i-1})$.

To briefly indicate the nature of the computational requirements, the following derived demand equation for California fresh oranges has been used in a simultaneous equation model:

$$(12) \quad QCFO = 5.787 - 46.353(PCFO/PRFO) - 0.827\,WND$$

where

$QCFO$ = quantity of California oranges for fresh use

$PCFO$ = on-tree price of California fresh oranges

$PRFO$ = U.S. retail price of fresh oranges

WND = nondurable wage rate in United States

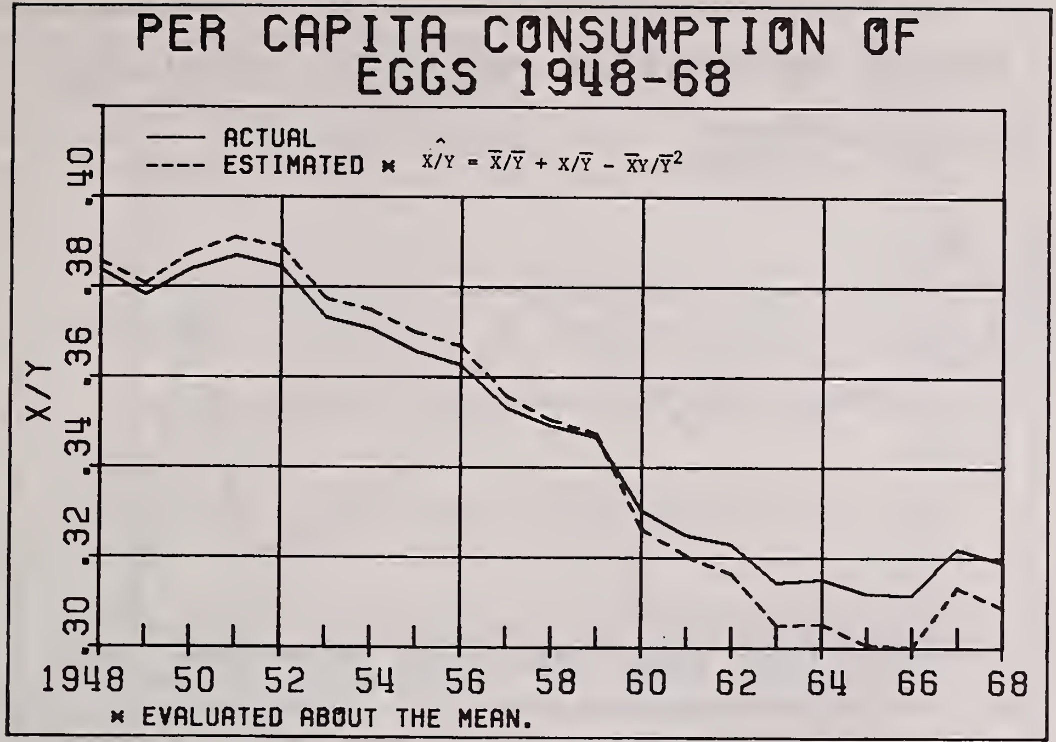

Figure 5

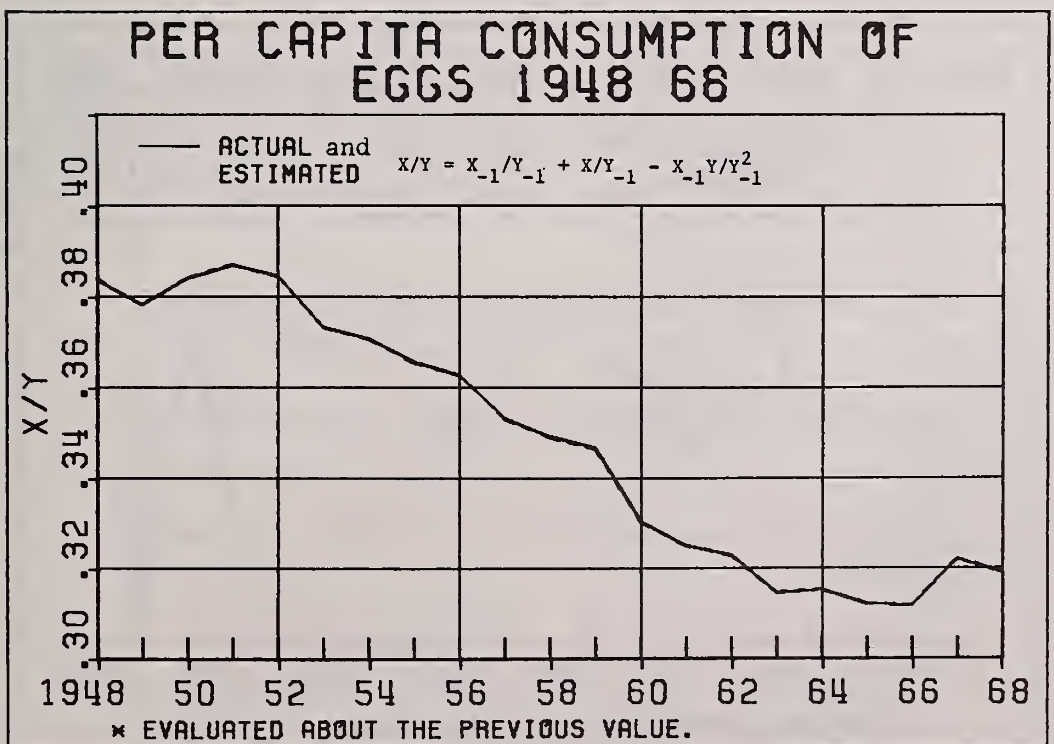

Figure 6

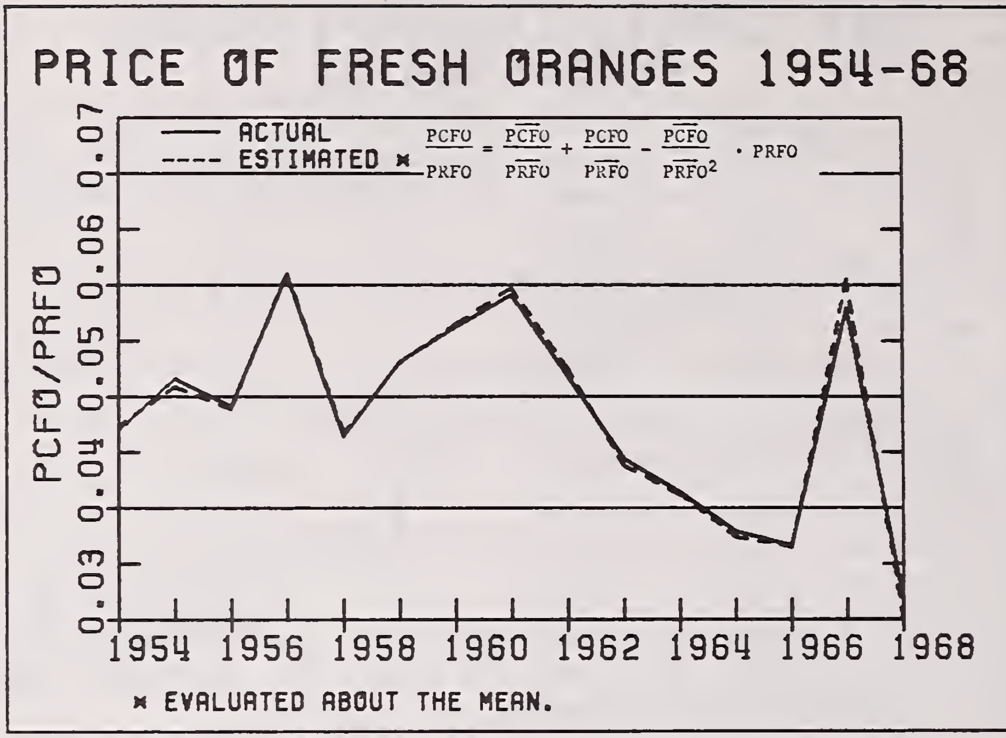

Figure 7

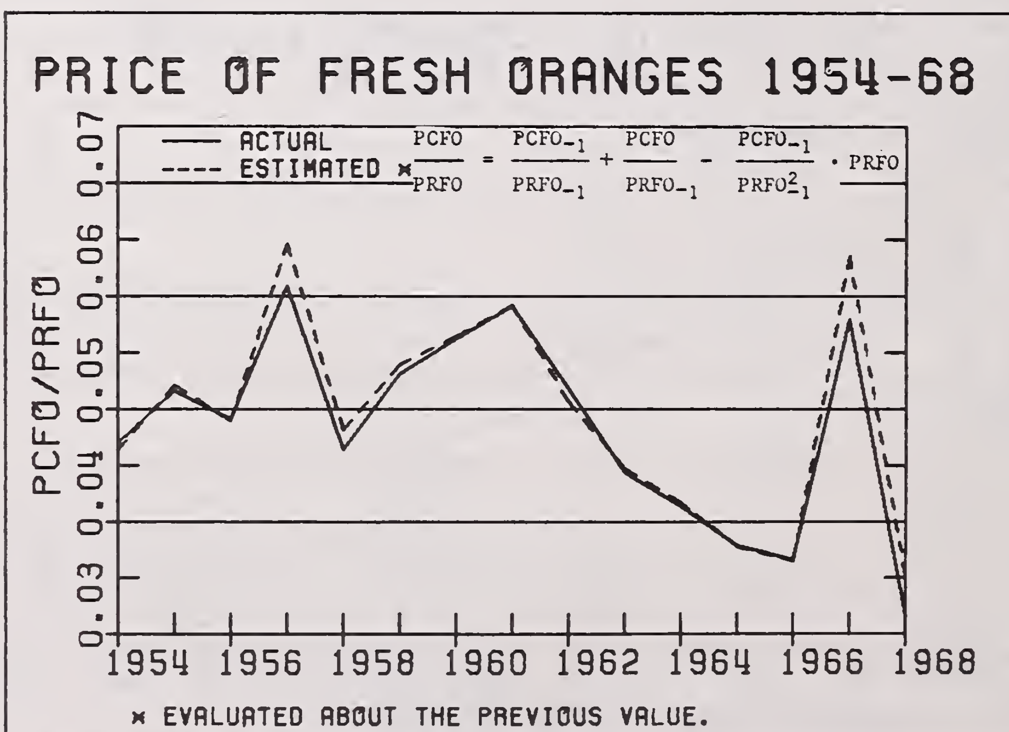

Figure 8

Since $QCFO$, $PCFO$, and $PRFO$ are endogenous to the model, relation (12) can be reexpressed in linear form if a reduced form solution is desired. Since a ratio of two variables is used in the equation, application of relation (10) evaluated about the means of $PCFO$ and $PRFO$ results in the following linear expression:

$$(13) \quad QCFO = 3.545 - 0.6118(PCFO) + 0.02959(PRFO) - 0.827(WND)$$

where

$$\overline{PCFO} = 3.66$$

$$\overline{PRFO} = 75.8$$

This expression in (13) is readily used in a reduced form solution and is acceptable if the bias or residual errors of the linear approximation of $PCFO/PRFO$ are small as is indicated in figure 7.

Should residual error be a problem as suggested in figure 5, the use of lagged values for evaluation points might be used but the required computational procedures for a reduced form solution of the system may not be the best solution technique for the analyst to use. Other solution techniques such as the Gauss-Siedel technique should be considered (*4*, *6*). For example, evaluation of (12) about the previous period value leads to the following more complicated relation when the linear approximation is substituted for $PCFO/PRFO$:

$$(14) \quad QCFO = 5.787 - 46.353\,[PCFO_{-1}/PRFO_{-1} + (1/PRFO_{-1})PCFO - (PCFO_{-1}/PRFO^2_{-1})PRFO] - 0.827\,WND$$

or

$$QCFO = 5.787 - 46.353(PCFO_{-1}/PRFO_{-1}) - 46.353(PRFO_{-1})PCFO + 46.353(PCFO_{-1}/PRFO^2_{-1})PRFO - 0.827\,WND$$

Since the b's in (14) are dependent on lagged values of $PCFO$ and $PRFO$, matrix inversion of the endogenous coefficients is required each period. With the present computer capacity, more efficient solution techniques are available.

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Corn Acreage Response and the Set-Aside Program*

By Mary E. Ryan and Martin E. Abel

This paper modifies and employs a model previously developed for empirical evaluation of the impact of commodity price-support programs on corn acreage. (See J. P. Houck and M. E. Ryan, "Supply Analysis for Corn in the United States . . . ," Amer. Jour. Agr. Econ. 54: May 1972; and J. P. Houck and A. Subotnik, "The U.S. Supply of Soybeans . . . ," Agr. Econ. Res. 21 (4); 99-108, Oct. 1969.) This model is used to analyze the effect of the set-aside program on corn plantings. Estimates for corn acreage planted in 1971 range from 73.6 to 74.6 million compared with actual plantings of 74.7 million acres. For 1972, 68.1 to 69.7 million acres of corn are predicted.

Key words: U.S. corn supply; Government programs; policy; regression analysis; acreage response.

The recent analytical and empirical work on U.S. corn acreage supply functions discussed in this paper is part of an ongoing research project sponsored jointly by the U.S. Department of Agriculture and the Department of Agricultural and Applied Economics at the University of Minnesota. This investigation builds upon earlier analyses of corn supply by Houck and Ryan[1] and of soybean supply response by Houck and Subotnik.[2] The major goal of this research has been to develop reliable tools for policy advisers to use for estimating the aggregate acreage consequences of changes in Government commodity program provisions. Hence emphasis has been devoted to empirical measurement and analysis of the effects of policy variables on acreage planted.[3]

In the two previous papers the concept of an "effective" or "weighted" price support rate was developed as a means of incorporating both acreage restrictions and announced price supports into a single term subject to empirical measurement or estimation. Support rates were adjusted to account for acreage controls in various annual programs. Additional payments made by the Government for withholding land from production of a specified crop were treated as a supply shifter. Acreage planted was assumed to be a function of the adjusted or weighted price support, land diversion payments, and other supply determinants.

Specific objectives of this paper are (1) to adapt the basic model for analysis of set-aside program provisions, and (2) to modify the calculations of the original policy variables to account for a change in the program introduced in 1966.

The Theoretical Model

Figure 1 illustrates the model. Assume that S_1 is a static acreage supply function for a crop at various price support levels. Acreage is measured along the horizontal axis and support price along the vertical axis. At the announced price support of PA, producers would plant A_1 if there were no restrictions or conditions attached to the price support. But if policymakers wish to reduce acreage to, say, A_2, they could (1) drop the support rate to PF, (2) attach acreage-restricting conditions to obtaining the higher PA so that, on balance, acreage planted falls to A_2, (3) make diversion payments sufficient to shift the supply function to S_2, or (4) employ some combination of these three options. During 1956-58 and 1961-70, all three options were utilized in corn programs. Support payments were lowered somewhat, qualification for payments was tied to restricted corn plantings, and additional payments were made for withdrawing land from corn production. Under the 1971 set-aside program, option (3) was relied upon exclusively to reduce acreage planted. For 1972, a

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[1] J. P. Houck and M. E. Ryan, Supply Analysis for Corn in the United States: The Impact of Changing Government Programs, Amer. Jour. Agr. Econ. 54: May 1972.

[2] J. P. Houck and Abraham Subotnik, The U.S. Supply of Soybeans: Regional Acreage Functions, Agr. Econ. Res. 21 (4): 99-108, October 1969.

[3] Research with other objectives, such as evaluation of program costs or income effects on various regions or farm types, would be likely to take different forms.

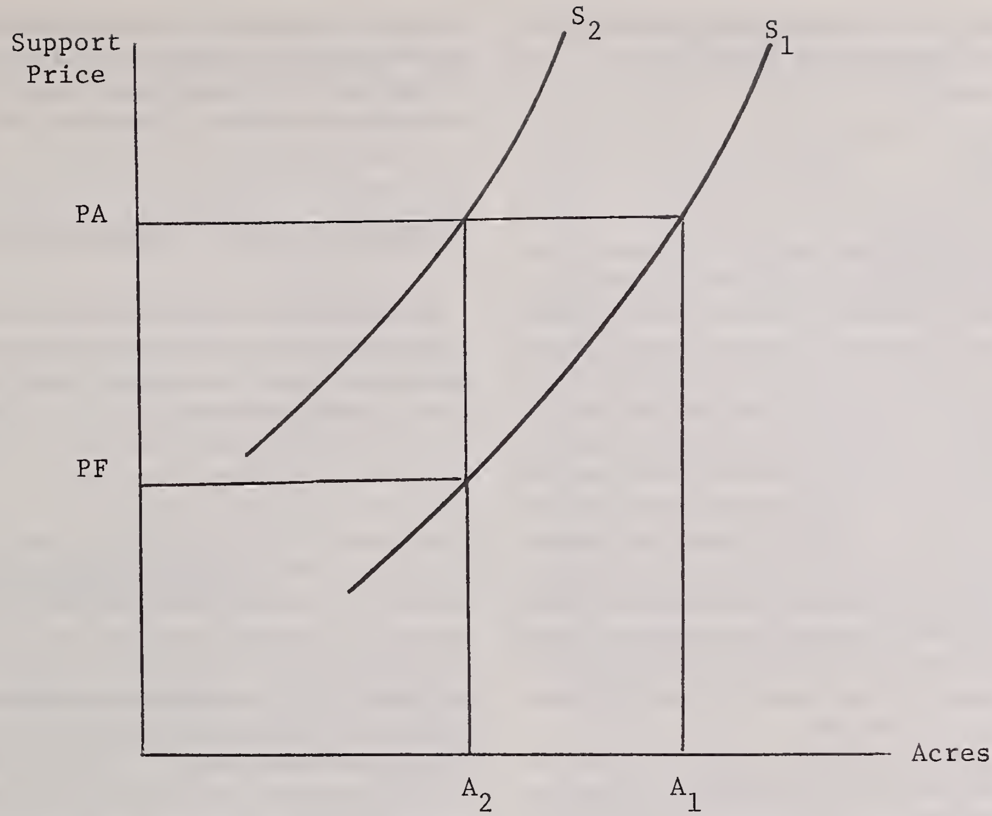

Figure 1

combination of (2) and (3) will be employed again. Option (1) was the method used solely in 1959 and 1960 when no planting restrictions applied.[4]

This model may be expressed as

(1) $A = f(PF, DP, Z)$

where A is corn acreage planted in the United States, PF is the support price weighted by planting restrictions, DP represents payments for diverting land from corn production, and Z includes other supply determinants and random factors. The analytical and empirical problems are to determine how to calculate PF and DP for any given set of program provisions.

Assume that

(2) $PF = rPA$,

and that

(3) $DP = wPR$

where PA is the announced support rate, r is the adjustment factor reflecting planting restrictions, PR is the payment rate for diversion, and w is the proportion of acreage eligible for diversion payments. Generally, the ranges of r and w are between 0 and 1.0. If no planting restrictions are imposed for obtaining PA, r equals 1.0. Similarly, if all land may be diverted for payment, w equals 1.0. The tighter the planting restrictions, the closer r will be to zero; and, the smaller the permitted diversion acreage, the closer w will be to zero. The values of PF and DP are seen to depend both upon payment levels (PA and PR) and upon the amount of acreage eligible for payment (r and w). Changes in any of these four variables, holding the others constant, will affect acreage planted. Increases in r or PA will

[4] In 1959-60, however, the price support was not lowered enough to sufficiently reduce acreage during those years to bring supply into balance with demand. Likewise, diversion payments were insufficient in 1971 to shift the supply function far enough to curtail output to the desired level. This should not imply that options (1) and (3) *cannot* be made to work but merely that they *were not* made to work, for a variety of reasons which are incidental to the argument of this paper.

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raise PF and increase acreage; increases in w or PR will increase DP and decrease acreage planted.

Market Prices

The supply relationship considered in this paper does not explicitly include lagged or expected market prices. This is because market prices for corn have depended upon Government programs in most years since World War II—the period of study. Even since 1963, when market prices moved above the loan rate in all but one year, the supply control features of the programs, by curtailing output, have influenced the overall level of and annual variations in market prices. Program features are adjusted annually to elicit a supply in line with anticipated demand at some target price. Restrictive features are eased when output expansion is desired and, when output reduction is sought, incentives to reduce output are increased. Hence market prices are depressed or buoyed respectively from what they would be in the absence of changes in programs.

The argument that output response is related to policy variables may also be extended to producers who do not participate in Government programs. For instance, a relatively high price in year t-1 indicates a short supply situation. Program planners react to the short supply by easing output control programs in year t to increase output. And, if nonparticipants respond to the high price by increasing corn acreage in year t, they act in accord with the program changes. In a low-price, surplus situation, the converse would be true. Thus, as long as there is excessive productive capacity at the existing price level (the situation for corn throughout the postwar years) and as long as policymakers effectively control output, supply can be considered a function of Government programs, without separate consideration of market prices.

Policy variables can, in other words, capture the effect of market prices in inducing changes in supply; nothing is added to the analysis by the addition of market prices. Moreover, the close relationship between the two may present statistical difficulties and thereby be detrimental to the analysis.[5] This is not to infer that the market price plays no role. The amount demanded depends upon the market price and is an important consideration of program planners when they determine payment levels and acreage restrictions.

Calculation of Policy Variables (*PF* and *DP*)

The weighted price support rate (PF) was calculated according to equation (2) where r was assumed to be the proportion of the base acreage permitted for corn planting by program participants.[6] To account for the range of permitted planting provided for most years, the minimum and maximum shares allowed were averaged. This is the simplest way to enable PF to reflect changes in minimum or maximum program requirements. For example, in 1963, farmers could qualify for the \$1.25 total support payment (\$1.07 loan and 18 cents support payment) if they planted between 0.6 and 0.8 of their base acreage. Hence, for 1963, $r = 1/2(0.6 + 0.8) = 0.7$ and $PF = 0.7(1.25) = 0.875$. In years without planting restrictions on corn (1948-49, 1951-53, 1959-60, 1971), $r = 1.0$ and $PF = PA$.

The computations of values for DP are according to equation (3). If the payment rate differed for various levels of diversion, equation (3) was disaggregated, i.e.,

$$DP = w_1 PR_1 + w_2 PR_2$$

where the subscripts 1 and 2 refer to different payment rates for different portions of the diverted acreage. Furthermore, since a range of diversion was allowed for most years, minimum and maximum provisions were averaged as was done in calculating PF. For instance, for 1966 a minimum of 20 percent and a maximum of 50 percent of the base acreage could be diverted for payment. The payment rate was 75 cents per bushel for estimated production on the first 20 percent of the base diverted and 65 cents per bushel

[5] For 1949-69, Houck and Ryan, op. cit., found a high correlation between the weighted price support in year t (PF_t) and the average price received by farmers for corn in year t-1 (P_{t-1}), as well as a linear trend factor (T). The regression equation is

$$PF_t = \underset{}{0.1717} + \underset{(4.9)}{0.8983\, P_{t-1}} - \underset{(3.4)}{0.0185\, T}$$

$$R^2 = 0.86$$

where the numbers in parentheses are t-values. That is, a given change in the market price was associated with a similar change in the weighted price support for the following year about 90 percent as large as the market price change, adjusted for a small negative secular change.

[6] This method of estimating r is treated in more detail in the two papers referred to earlier.

on the next 30 percent of base acreage diverted.[7] Therefore, $w_1 = 0.2$, $w_2 = 0.3$, $PR_1 = 0.75$, $PR_2 = 0.65$, and $DP = 1/2[0.2 \times 0.75) + (0.2 \times 0.75 + 0.3 \times 0.65)] = 0.248$. The term (0.2×0.75) represents the diversion payment for the minimum level of participation only. The other term, $(0.2 \times 0.75 + 0.3 \times 0.65)$, represents *DP* for the maximum diversion of 50 percent of the base. Because the payment rate (*PR*) differs between the first 20 percent and the second 30 percent diversion, there are two parts to this term. The terms for minimum diversion and maximum diversion are averaged in the calculation of *DP* so that changes in either minimum or maximum program requirements will be captured by the policy variable.[8]

Calculations of Policy Variables for Set-Aside Program Provisions

The policy variables *PF* and *DP* can be computed to reflect set-aside provisions as offered in 1971 and 1972 corn programs. For 1971, the announced support price, *PA*, was guaranteed for all corn grown without a specific restriction on corn plantings. Hence, in computing *PF* from the equation $PF = rPA$, $r = 1.0$, implying no restriction on corn plantings, and $PF = PA$. For 1971, the value of *PF* was \$1.05, the loan rate. Compare this with *PF* for 1970 when the loan rate was the same but planting was restricted to between 50 and 80 percent of base acreage. Hence $r = 1/2(0.5 + 0.8) = 0.65$ and $PF = (0.65)(1.05) = 0.68$. The increase of *PF* from 0.68 in 1970 to 1.05 in 1971 reveals the increased incentive to plant corn resulting from removal of planting restrictions, according to our calculations.

In 1971, the only requirement for participation was to idle cropland equal to 20 percent of the participant's base acreage. A payment was made for this diversion, thus shifting the supply function of the participant to the left. The diversion payment rate, *PR*, was 80 cents; thus, according to the equation $DP = wPR$, $DP = (0.2)(0.80) = 0.160$. No additional optional diversion was offered, so no averaging of minimum and maximum provisions is required.

Program provisions for 1972 are more complex. Provisions for minimum diversion are like those for 1971 except that the required minimum set-aside was increased from 20 to 25 percent of base acreage. The loan rate (*PA*) was continued at \$1.05 and the diversion payment (*PR*) at 80 cents. In addition, two plans are offered for additional voluntary diversion: plan A (the original provisions) and plan B (the new option offered in February 1972). For both plans an additional diversion of 10 percent is assumed here to be the maximum possible for payment.

Under plan A, an additional 10 percent of base acreage may be idled for payment at the rate of 52 cents per bushel. No restriction is placed on corn planting. Hence the calculations of *PF* and *DP* are

$$PF = 1.05$$

$$DP = 1/2[(0.25 \times 0.80) + (0.25 \times 0.80 + 0.10 \times 0.52)] = 0.226$$

PF equals the loan rate because $r = 1.0$ (no planting restrictions). The term (0.25×0.80) in the *DP* computation represents the diversion payment for the minimum level of participation only. The other term, $(0.25 \times 0.80 + 0.10 \times 0.52)$, represents *DP* for the maximum set-aside, considered to be 35 percent in this discussion. A simple average of the two terms gives a *DP* reflecting both minimum and maximum participation provisions.

Under plan B, up to an additional 10 percent of base acreage may be idled for payment at the rate of 80 cents *if* corn planting is restricted. The restriction is related to 1971 corn plantings. For each acre voluntarily idled for payment, corn acreage must be reduced 2 acres below the amount planted in 1971. For instance, if the entire 10 percent of additional acreage is diverted for payment, acreage equivalent to 20 percent of the base must be subtracted from acreage planted to corn in 1971. For this plan, *PF* and *DP* would be:

$$PF = 1/2[(1.0)(1.05) + (0.8)(1.05)] = 0.945$$

$$DP = 1/2[(0.25 \times 0.80) + (0.25 \times 0.80 + 0.10 \times 0.80)] = 0.240$$

[7] The payment for the required 20 percent diversion is called a support payment in the language of the program but since it functions as a payment for minimum diversion it is treated as a diversion payment here. The payment was 30 cents per bushel for 50 percent of the base. By treating this payment as a diversion payment for the required 20 percent diversion, this amounts to 75 cents per bushel for 20 percent of the base ($0.30 \times 0.5 = 0.2X$, which gives $X = 0.75$).

[8] The importance of accounting for both minimum and maximum diversion payments in the calculation of *DP* may be discerned in the calculation for 1965. In that year, the diversion payment for minimum diversion (20 percent) was 40 cents a bushel but the payment for maximum diversion (50 percent) was \$1.00 per bushel for the entire diverted acreage. Hence, $DP = 1/2[(0.2 \times 0.40) + (0.5 \times 1.00)] = 0.290$.

In the *PF* calculation, the term (0.8)(1.05) reflects the restriction on corn planting to qualify for the program at the 10 percent additional set-aside level. The value 0.8 is used because eligible acreage for corn planting is assumed to be 80 percent of 1971 plantings.[9] The actual percentage reduction will vary considerably from farm to farm depending upon the assigned base acreage and 1971 plantings but, in the aggregate, it can be assumed to average about 20 percent.

For 1972, it is likely that both plan A and plan B will be utilized because A will be more profitable for some producers and B for others. The question, then, is which set of values for *PF* and *DP* should be used to predict 1972 corn acreage, or should some combination of the two plans be used? Without knowledge of participation rates under the two plans, one way to account for both in the estimation process is to take a simple average, which yields: *PF* = 1.00 and *DP* = 0.233. All three values of *PF* and *DP* are employed later to predict 1972 acreage from estimators derived from 1949-70 observations.

Calculated values for *PF* and *DP*, along with the announced support rate, *PA*, are contained in table 1 for 1948-72.[10] For 1948-65 these values are identical with those used in the previous Houck-Ryan corn supply analysis. Beginning with 1966, however, the direct support payment is considered here as a diversion payment rather than as a supplement to the loan rate as it was treated in the earlier work.[11] The variable *PA* is merely the announced national average loan rate, plus direct support payments for crop years 1963-65. Support payments for these 3 years functioned as supplemental payments for production, increasing with output and decreasing if output were cut back. In 1966 and subsequent years, support payments are a fixed amount and hence function as a diversion payment.

Empirical Results

Using the policy variables and other independent variables, corn acreage supply functions for the United States were estimated by ordinary least squares. The statistical estimation encompasses 22 crop years, from 1949 through 1970. The results of three estimations are shown in table 2 and figures 2, 3, and 4.

Corn program policy variables, *PF* and *DP*, contribute importantly to the explanation of changes in acreage planted. A 10-cent increase in *PF* results in an estimated increase of 895,000 to 979,000 acres in planted acreage. The estimated effect of a 10-cent increase in *DP* is associated with a decrease of 4.4 to 5.2 million acres in planting.

Soybeans compete with corn for production resources since corn land is also generally desirable for growing soybeans. The support price of soybeans (*PSS*) is entered to measure this substitution. As estimated, a 10-cent increase in *PSS* leads to a decrease of 0.9 to 1.0 million acres in corn plantings.[12] Grain sorghum has been another important substitute for corn. Before 1961, sorghum acreage was not restricted. A farmer qualifying for feed grain loans could plant any amount he wished and could even plant sorghums on land

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[9] This assumption implies that the U.S. corn base available for planting, derived from 1959-60 corn acreage planted, is approximately the equivalent of the acreage planted to corn in 1971. A comparison of the corn base and 1971 corn acreage planted supports this assumption. The comparison was made as follows: 1971 corn acreage on farms participating in the Government corn program was divided into two groups. The first group consisted of acreage planted which was less than 80 percent of the assigned corn base acreage on participating farms, and the second group contained acreage which equaled or exceeded 80 percent of the base. (The 80 percent figure is used because it is the remainder of the base available for planting if the 1971 set-aside of 20 percent had come from the base.) For the first group, actual acreage planted to corn in 1971 was 12 million acres *less* than 80 percent of base acreage for this group; for the second group, actual corn acreage planted in 1971 was 11 million acres *more* than 80 percent of their base. Thus, in relation to the base, "underplanting" by the first group was just about equal to "overplanting" by the second group. Therefore, in the calculation of *PF* under plan B provisions, the average planting restriction for a 10 percent additional set-aside can be presumed to be a 20 percent reduction from 1971 acreage. (Data for the comparison were obtained from 1971 Set-Aside Programs Annual Report, Agr. Stabil. and Conserv. Serv., January 1972, p. 59.)

[10] Calculations are based on program details obtained from various issues of the Feed Situation, Econ. Res. Serv., 1947-72.

[11] This change had no appreciable effect on the explanatory power of the acreage supply equation.

[12] The estimated effect of changes in the soybean support rate should be viewed with special caution. Analyses with shorter time series (1949-59, 1960-69, and 1961-71) indicate that the effect was stronger prior to 1960 or 1961 than in recent years. The estimated coefficient based on data for the 1960's is about one-half the size of the coefficient for the entire series. The possibility that these equations overestimate the effect in recent years is further substantiated by observation of the estimated and actual acreage values for 1966 and 1969. In these 2 years the soybean rate was changed appreciably and the acreage estimates diverged from actual values to a greater extent than in other years. It is therefore suggested that, if the soybean support rate is changed in future years, a coefficient in the range of 4,000 to 6,000 be applied instead of the estimated 9,000 to 10,500. This would mean that a 10-cent increase in the soybean support rate would decrease corn acreage by 0.4 to 0.6 million acres instead of 0.9 to 1.0 million as estimated.

Table 1.—Announced support prices, calculated weighted support rates, and diversion payment rates per bushel of corn, 1948-72

Year	Announced support price (*PA*)	Weighted support rate (*PF*)	Diversion payment rate (*DP*)
	Dol.	*Dol.*	*Dol.*
1948	1.44	1.44	0
1949	1.40	1.40	0
1950	[a]1.47	1.15	0
1951	1.57	1.57	0
1952	1.60	1.60	0
1953	1.60	1.60	0
1954	[a]1.62	1.30	0
1955	[a]1.58	1.33	0
1956	[a,b]1.50	1.16	[f].043
1957	[a,b]1.40	.96	.043
1958	[a,b]1.36	.86	.052
1959	1.12	1.12	0
1960	1.06	1.06	0
1961	1.20	.84	.192
1962	1.20	.84	.192
1963	[c]1.25	.88	.112
1964	[c]1.25	.81	.180
1965	[c]1.25	.81	.180
1966	[d]1.00	.65	.248
1967	[d]1.05	.84	.150
1968	[d]1.05	.68	.241
1969	[d]1.05	.68	.241
1970	[d]1.05	.68	.231
1971	[d]1.05	1.05	.160
1972 (plan A) [e]	[d]1.05	1.05	.226
1972 (plan B) [e]	[d]1.05	.94	.240

[a]Loan rate in commercial corn area. Rates for noncommercial areas were $1.10 for 1950 and $1.22, $1.18, $1.24, $1.27, $1.02 for 1954 through 1958, respectively.

[b]Loan rates of $1.25, $1.10, and $1.06 for 1956, 1957, and 1958, respectively, were available for noncompliers in the commercial area. These values did not enter into calculations for this study.

[c] Direct support payments are included. They are 18¢ for 1963, 15¢ for 1964, 20¢ for 1965.

[d] Direct support payments beginning with 1966 are included with diversion payments because they have functioned as a payment for minimum diversion since then. Hence, *PA* consists only of the loan rate for these years.

[e] See the text for an explanation of plan A and B calculations for *PF* and *DP*.

[f] This value was omitted from analyses of corn acres planted since planting occurred before the program provisions were announced.

withdrawn from corn production in accordance with corn program requirements. Beginning with 1961, however, corn and sorghum substitution was curtailed. This program change was hypothesized to alter the corn-sorghum relationship at this point in the study period. The basic assumption is that acreage of these two crops was much more substitutable before 1961 than after. To account for this change in the analysis, actual sorghum acreage is entered as an independent variable prior to 1961 and then for 1961 to 1970 set at the mean value of the previous 12 crop years. The estimates indicate that a 1-acre increase in sorghum planting during 1949-60 reduced corn acreage by about 0.3 acre.[13]

These estimations differ from those in the Houck-Ryan paper in two respects. First, one more year (1970) is included here, and second, these equations contain a dummy variable (DV = 1 in 1966-70 and 0 in other years) to account for the change beginning in 1966 when support payments were shifted from the calculations of

[13]For a more detailed discussion of the corn-sorghum relationship, see Houck and Ryan, op. cit.

Table 2.—Estimation of U.S. corn acreage planted, 1949-70 (regression coefficients and t-values)

Dependent Variable = A

Equation	Constant	PF	DP	PSS	AGM	DV	T	Log T	R^2	$\bar{s}$
2-1	99,316.90	8,954.82 (3.2)	-48,061.40 (5.3)	-10,010.35 (4.7)	-0.34 (3.4)	7,016.16 (7.5)	-243.86 (2.2)		0.986	1,114.60
2-2	95,828.97	9,409.48 (3.2)	-52,323.32 (5.7)	-8,997.60 (4.0)	-.28 (2.4)	6,184.16 (7.0)		-2,598.52 (1.7)	.984	1,172.94
First Differences of All Variables										
2-3	-326.47	9,793.71 (3.7)	-43,898.97 (5.3)	-10,494.47 (4.2)	-0.26 (2.0)	8,689.21 (5.4)			0.927	1,450.00

Variable Descriptions

A = U.S. acreage of corn planted, in thousands

PF = U.S. average corn loan rate (plus direct support payments, 1963-65), weighted by acreage restriction requirements, in dollars per bushel

DP = corn acreage diversion payment rate, weighted by eligible diversion acreage, in dollars per bushel

PSS = U.S. average soybean price support loan rate, in dollars per bushel

AGM = U.S. acreage of sorghums planted for 1949-60 and the mean of 1949-60 acreage for 1961-70, in thousands

DV = 0 in 1949-65 and 1 in 1966-70

T = linear trend (1949 = 1, 1950 = 2, etc.)

Log T = 1949 = log of 1, 1950 = log of 2, etc.

$\bar{s}$ = standard error of the estimate

The values in parentheses are t-values of the regression coefficients.

PF to DP. Data used for these estimations are presented in appendix table 1.

Prediction of 1971 and 1972 Acreage

The equations in table 2 were employed to predict 1971 and 1972 corn acreage planted, using the PF and DP values already calculated and the appropriate values for the other variables. The results in millions of acres are shown in table 3.

Predicted 1971 acreage planted was very close to actual planting, yet it was slightly underestimated by all three estimators. The underestimation might be accounted for by more corn planting on small farms in 1971 than in previous years. (Special small-farm diversion features were discontinued when the set-aside program became effective.) These reasonably successful results suggest that this model and the manner employed

Table 3.—Predicted corn acreage

Item	Actual	Predicted by equation no.		
		2-1	2-2	2-3
1971	74.7	73.6	74.6	74.3
1972:[a]				
Plan A only		70.2	70.8	71.7
Plan B only		68.6	69.0	70.0
Average A & B		69.4	69.9	70.7
1972:[b]				
Plan A only		69.0	69.4	70.6
Plan B only		67.2	67.5	68.7
Average A & B		68.1	68.4	69.7

[a] All estimates based on a maximum allowable diversion of 35 percent of base acreage.

[b] Plan A estimates based on a maximum allowable diversion of 45 percent of base acreage and plan B estimates on a 40 percent maximum.

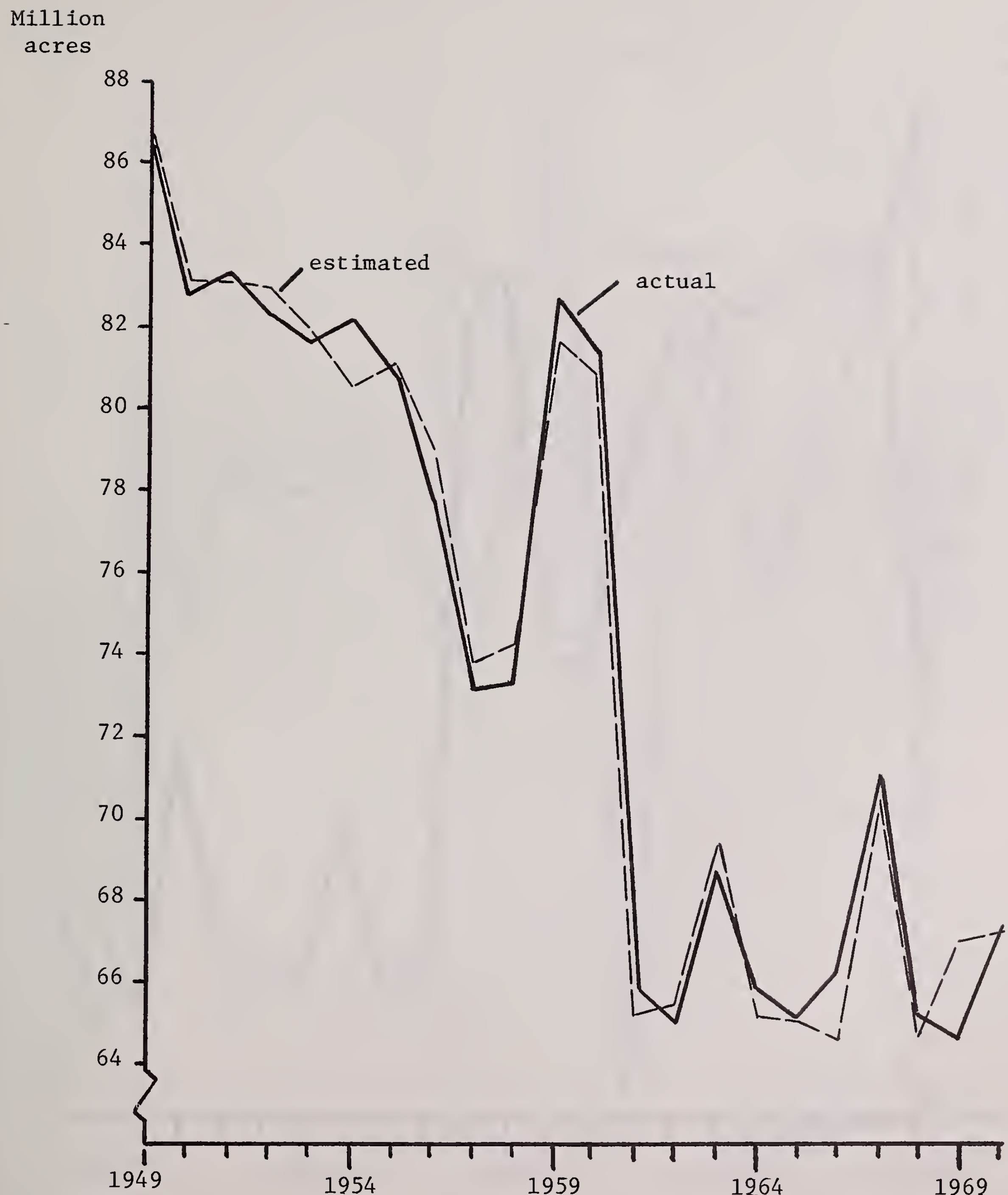

Figure 2.—U.S. corn acreage planted, actual and estimated, 1949-70 (equation 2-1).

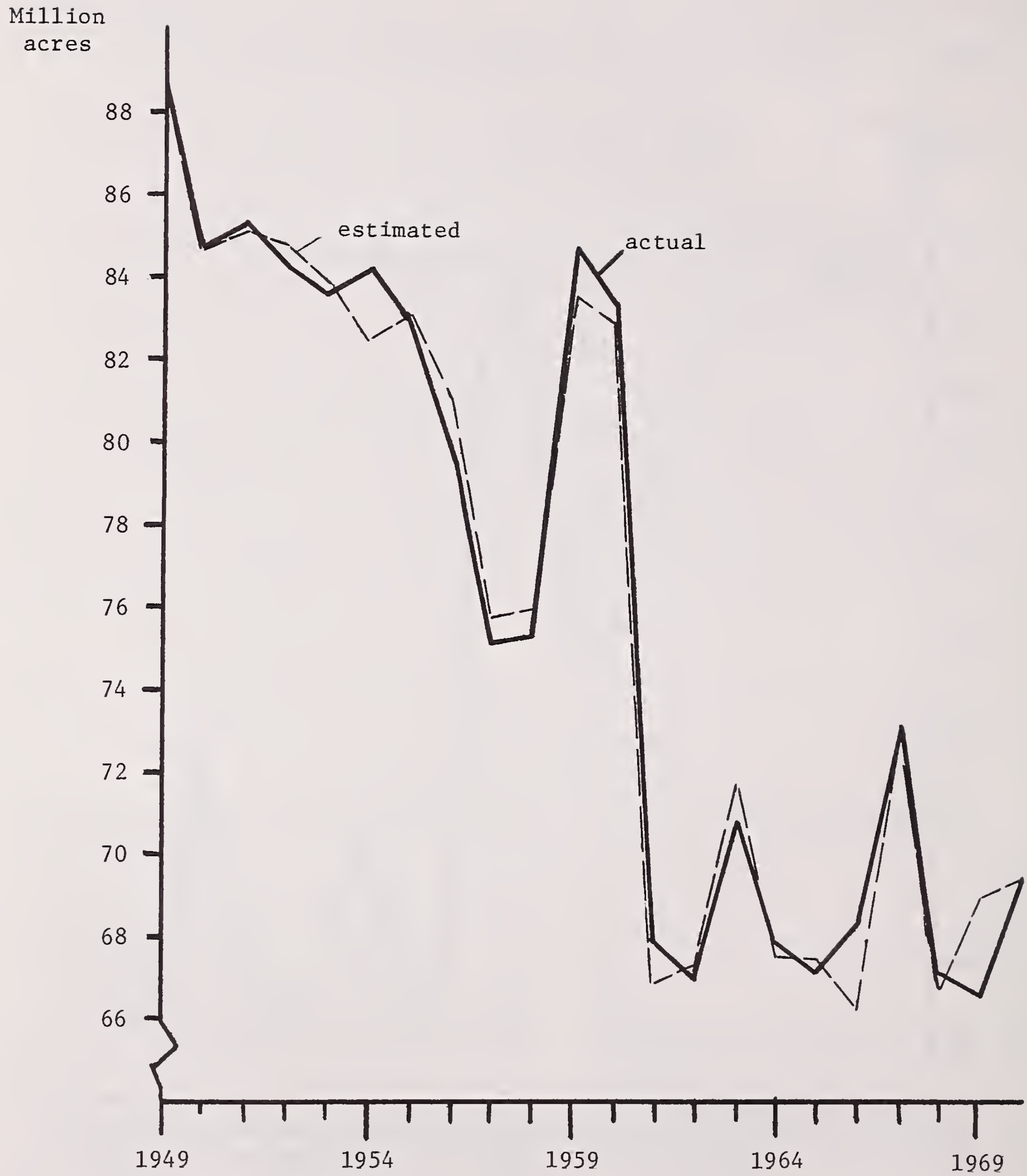

Figure 3.—U.S. corn acreage planted, actual and estimated, 1949-70 (equation 2-2).

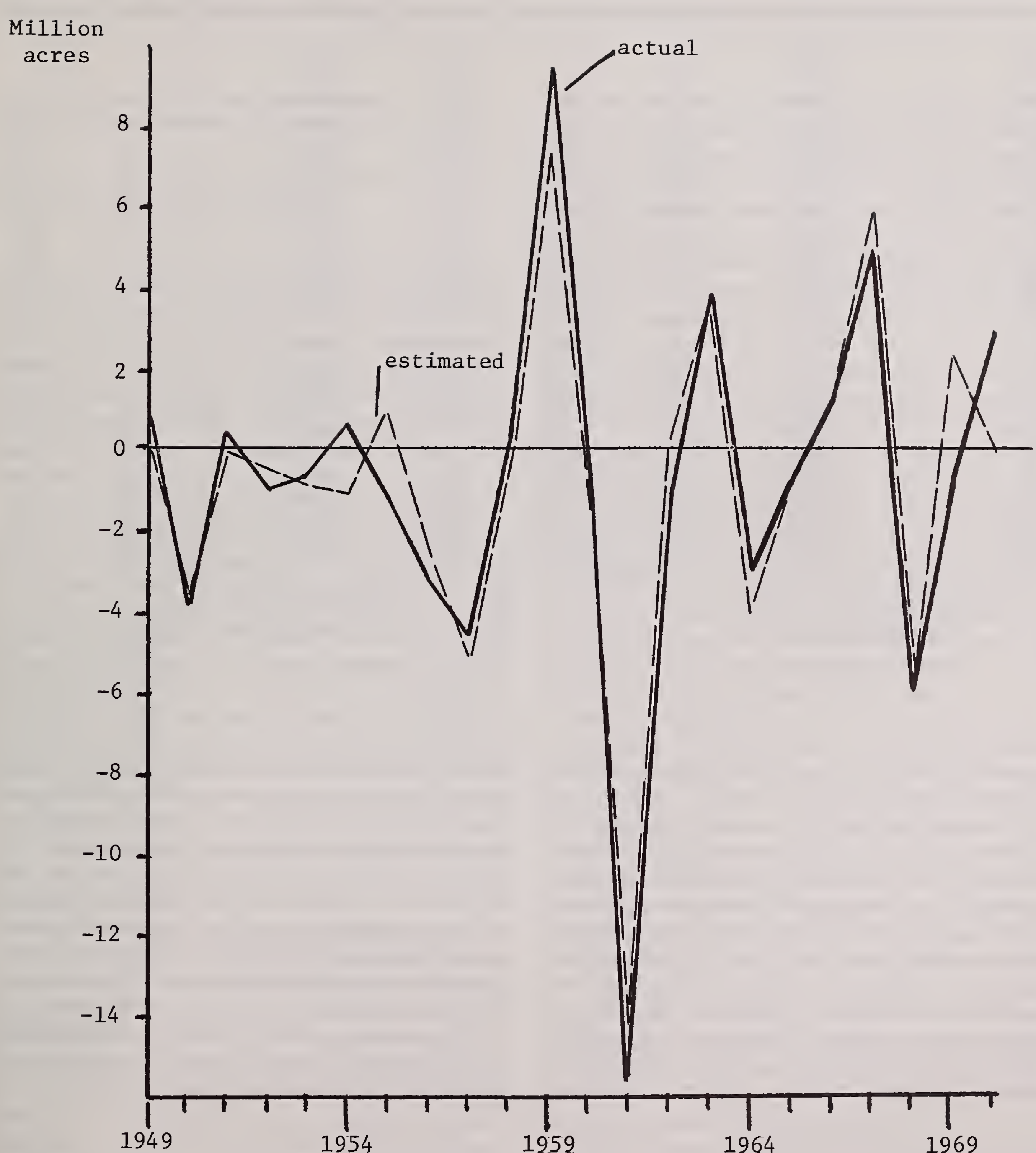

Figure 4.—Annual change in U.S. corn acres planted, actual and estimated, 1949-70 (equation 2-3).

Appendix table 1.—The data series

Crop year	*A*	*PF*	*DP*	*PSS*	*AGM*	*DV*	*T*	Log *T*
	1,000 acres	*Dol./bu.*	*Dol./bu.*	*Dol./bu.*	*1,000 acres*			
1948	85,522	1.44	0.0	2.18	13,214	0	0	--
1949	86,738	1.40	.0	2.11	11,064	0	1	0.0
1950	82,859	1.15	.0	2.06	16,055	0	2	.3010
1951	83,275	1.57	.0	2.45	15,028	0	3	.4771
1952	82,230	1.60	.0	2.56	12,289	0	4	.6021
1953	81,574	1.60	.0	2.56	14,590	0	5	.6990
1954	82,185	1.30	.0	2.22	20,148	0	6	.7782
1955	80,932	1.33	.0	2.04	23,921	0	7	.8451
1956	77,828	1.11	.0	2.15	21,384	0	8	.9031
1957	73,180	.96	.043	2.09	26,886	0	9	.9542
1958	73,351	.86	.052	2.09	20,675	0	10	1.0000
1959	82,742	1.12	.0	1.85	19,508	0	11	1.0414
1960	81,425	1.06	.0	1.85	19,598	0	12	1,0792
1961	65,919	.84	.192	2.30	18,429	0	13	1.1139
1962	65,017	.84	.192	2.25	18,429	0	14	1.1461
1963	68,771	.88	.112	2.25	18,429	0	15	1.1761
1964	65,823	.81	.180	2.25	18,429	0	16	1.2041
1965	65,119	.81	.180	2.25	18,429	0	17	1.2304
1966	66,306	.65	.248	2.50	18,429	1	18	1.2553
1967	71,093	.84	.150	2.50	18,429	1	19	1.2788
1968	65,126	.68	.241	2.50	18,429	1	20	1.3010
1969	64,476	.68	.241	2.25	18,429	1	21	1.3222
1970	67,352	.68	.231	2.25	18,429	1	22	1.3424

A	=	U.S. acreage of corn planted	*PSS*	=	soybean support rate
PF	=	weighted support rate	*AGM*	=	U.S. acreage of sorghums planted
DP	=	weighted diversion payment	*DV*	=	dummy variable

to estimate policy variables provide a useful tool for farm policy advisers.

The predictions for 1972 encompass a selection of the options offered. Under the original 1972 provisions, plan A, 1972 acreage of 70.2 to 71.7 million would be expected if the maximum allowable diversion were limited to 35 percent of the base acreage. Planted acreage would be reduced to 69.0 to 70.6 million if the extra 10 percent diversion were also allowed. Under the new option announced in February 1972, plan B, planted acreage is estimated at between 68.6 and 70.0 million acres if the maximum allowable set-aside is limited to 35 percent of the base, and between 67.2 and 68.7 million acres if the maximum is raised to 40 percent. To predict acreage under both provisions, plan B estimates were averaged with plan A estimates to obtain the values identified as average A and B. According to these predictions, 1972 corn acreage will fall 4.0 to 5.3 million acres below 1971 planting if maximum diversion is limited to 35 percent of the base and will fall an additional 1.0 to 1.3 million acres if plan A maximum diversion is increased to 45 percent and plan B maximum diversion is increased to 40 percent.

These estimates are very close to the 68.5 million acres of corn which farmers indicated they would plant in the March 1, 1972, planting intentions survey.

BOOK REVIEWS

Economic Models and Quantitative Methods for Decisions and Planning in Agriculture

Edited by Earl O. Heady. Iowa State University Press, Ames, Iowa, 50010. 518 pages. 1971. $10.50.

The papers in this collection were presented at an East-West Seminar in Hungary in 1968. The seminar, sponsored by the Ford Foundation, was organized to bring together the leaders of the academic and professional world who are engaged in building and applying planning models for agriculture. There were 92 participants in the seminar, representing 15 countries of Eastern Europe, Western Europe, and North America.

I approached this book with the reservations usual toward conference proceedings; however, it proved to contain many pleasant surprises. It is an interesting and educational book for anyone interested in the application of mathematical economic models for planning in agriculture. Perhaps the most valuable aspect of the book is the many comparisons and contrasts of planning in socialistic and capitalistic economies. In the socialistic economies, the planning models are being directly utilized as part of the planning process, whereas the capitalistic economies have largely left the use of planning models to the academicians. However, one would have to conclude that similarities in objectives and problems of application far outweigh the dissimilarities in the different economies.

Despite the greater reliance on planning models in the socialistic world, the leaders of methodology and application have been in the United States, judging from literature citations. Heady and his followers are recognized as the pioneers of building planning models for agriculture the world over. The foundations of economic theory and a market system for price indicators are advantages for the capitalists. Danilo Pejin points to Karl Marx's theoretical analysis of the reproduction process as the starting point for the methodology of planning in Yugoslavia. It turns out, however, that social objective functions, resource constraints, and production activities result in planning models and decision criteria very similar to those being used in the capitalistic world.

Linear programming stands out as the most widely applied tool for agricultural planning in all countries and at every level of planning. Other forms of nonlinear programming, econometric models, growth models, simulation, game theory, and activity analysis have their place and are frequently used with success. However, linear programming, with its many possible applications, accounts for more effort and more answers in agricultural planning than all the other tools combined.

The organization of the seminar and the resulting book make it difficult to comment on particular parts of the book. The seminar lasted 10 days. In general, a major paper and a discussion, each with a brief presentation, set the stage for a half-day discussion. The book is organized into six parts dealing with Foundation and Background in Planning Models, Problems and Potentials at the Micro Level, Regional Models of Planning and Development, Experiment and Experiences with National Planning Models for Agriculture, Formulation of National Models, and Gaps Between Plans and Realization and Practical Possibilities for Improvement in Performance.

There is considerable overlap in content among the six sections. The reader would be advised to sample rather than attempt a complete reading. The micro level section is better developed than the others. However, there are some worthwhile papers in every section. The last section on measurement of gaps between plans and accomplishment has some very interesting comments. Though some difficulty apparently exists in the definition and measurement of performance gaps, it is obvious that planning models are reaching a level of practical use. Many improvements are still to be made, however, particularly in building the bridges between micro, regional, and national level models. One is struck with the frustrations and problems that still confront planners and model builders everywhere.

With 46 separate presentations, it is hard, and perhaps dangerous, to single out particular papers for comment. Nevertheless, some do stand out. The paper by Gerhardt Tinter (USA) shows unique breadth in presenting a wide array of planning models, though a good many of them cannot be practically applied because of various mathematical or data problems.

Danilo Pejin (Yugoslavia) and Olf Renborg (Sweden) make some interesting comments regarding the underlying economic theory of planning models. The paper by Gunther Weinschenk (German Federal Republic) provides a worthwhile section on recent developments in mathematical programming. Vladimar A. Mash and V. I. Kiselev (USSR) present a stimulating paper on a proposed model for regional agricultural planning in the USSR. The discussion by Theordor Heidhues (German Federal Republic) raises some very penetrating questions about the content of the Mash-Kiselev paper.

The comments by Heidhues illustrate one of the weaknesses of this book. Many times, questions raised by a paper or its discussants are never answered for the reader. Obviously, these questions were discussed and debated in the seminar at some length but the reader can only guess at the outcome. Another weakness of the book is duplication among the various papers. Some could have been eliminated by editing to save the reader some needless repetition. Similarly, some subjects are treated too lightly or not at all. Finally, the readability of the book suffers because of the many writing styles that are present. While all papers have been translated to English from their original language, some obviously came through the translation better than others.

The book would be a valuable asset to the student of economic development, particularly as an aid to understanding the planning processes in many countries and the importance that is attached to agriculture in the achievements of an economy. The book should also be required reading for any economist who has an interest in the application of planning models to agriculture.

Norman K. Whittlesey

Impact of Uncertainty on Location

By Michael John Webber. The MIT Press, Cambridge, Mass. 02139. 310 pages. 1972. $15.

Uncertainty about spatial economic relationships spurs the growth of cities, possibly at a rate faster than would be socially optimal under conditions of perfect knowledge. Economists have been slow about incorporating time, space, and uncertainty into their analytical frameworks. Webber is a geographer willing to meet these difficulties head-on. His effort contains a good deal about the relationships between space and uncertainty, a little about interplays over time, and not much economics.

The first third of Webber's book is a concise, balanced review of the literature, sprinkled with evaluative judgments which make sense. There is a review of Alfred Webber's explanation of location of manufacturing industry and of subsequent contributions of Losch, Christaller, and others to the analysis of point agglomerations. Following is a review of von Thunen, Dunn, and others on theories of land use. These two chapters are excellent, evaluative summaries for readers who have a nodding acquaintance with the subject; beginners may find the discussions too brief, advanced readers will find them too long. The chapter reviewing theories of regional and national growth is less interesting than those on point agglomeration and land use; possibly there isn't much interesting literature to review on the relationships of growth and space. The review of decisionmaking under uncertainty is very selective, concentrating on aspects of probability theory and game theory needed to follow the arguments in subsequent chapters. Webber draws again on his fine talents to collect diverse threads into a meaningful summary in the final chapter of his book, with a review of his own contributions. However, the burden of success of Webber's book should not be on his review discussions, but rather on those four chapters, in which he makes his own contributions.

Webber draws upon game models, probability models, and hypothetical simulations to make a series of points about the relations between space and uncertainty. In his own words, this effort "represents merely the first stage in the creation of a general theory of location under uncertainty which links individual and social process, and has done little more than identify some of the processes at work." In other words, Webber has revised and devised a series of clever little models, each of which is capable of helping the reader find insights into the problem; but he has not woven these into a system. He has no overall theory from which to deduce each of the clever little models; he makes little use of and shows little appreciation for general economic theory. That is, Webber's little interesting pieces add up to a collection of little, interesting pieces.

Uncertainty on the part of firm managers about markets, sources of supply, and levels of productivity, says Webber, tend to send them to the obvious, or safe, location—the center of the market. This may not be an optimal location given more knowledge. Uncertainty can raise distance costs, increase inventories held for insurance, reduce the size of plant,

and increase external economies of scale. Innovation has a higher probability of occurrence in a concentrated area; and diffusion processes, or learning curves, may result in accelerated growth in concentrated areas relative to remote ones as innovations are adopted.

These and other uncertainty-space relationships discussed by Webber tend to increase the degree of concentration and may result in patterns which are suboptimal. To the extent that planning reduces uncertainty, society may seek Pareto-better changes in the location of economic activity through central planning such that some firms and households are made better off while none are made worse off. One result of these changes would be toward a more rural-oriented society.

If you are interested either in a good review of location literature or in a source of some useful insights into the importance of uncertainty in space relations, then Webber's book on the impact of uncertainty on location is recommended.

Clark Edwards

Social and Economic Issues Confronting the Tobacco Industry in the Seventies

Edited by A. Frank Bordeaux, Jr., and Russel H. Brannon. College of Agriculture and Center for Developmental Change, University of Kentucky, Lexington, Ky. 40506. 332 pages. 1972.

A series of developments is likely to bring about profound changes in the U.S. tobacco industry during the next decade. The objective of this book is to examine these expected changes and to appraise their likely social and economic impacts. The volume is based on 18 papers presented at a conference at the University of Kentucky in 1971.

Approximately one-half of the volume is oriented to an analysis of the health, production, marketing, and processing aspects of the tobacco industry. Taken as a group, these analyses strongly suggest that demand for U.S. tobacco will decline during the 1970's. Slightly less than one-fifth of the volume addresses the question of what impact the decline in the demand for U.S. tobacco will have on producers, the economy, and the population in tobacco areas. The consensus is that in relative terms the impact on the national economy will be minor. However, an important part of the income and employment of many small tobacco farmers and hired farmworkers may be eliminated, and tobacco areas may experience substantial outmigration in the 1970's. The remaining 30 percent of the book is devoted to evaluating tobacco programs and policy prescriptions for the 1970's.

The major strength of this book is its excellent analysis of the problems of the tobacco industry. A large number of very relevant problems are addressed and the latest available research is used to analyze these problems. The analyses are technically competent and well articulated. In this sense, the volume provides an excellent treatment of the problems and issues of the tobacco industry.

The major shortcoming of the volume is that it fails to address in a meaningful way one of the more important aspects of the tobacco adjustment problem. It is very likely that a substantial reduction in tobacco-dependent employment and income will accompany the expected adjustments in the tobacco industry, particularly in the major tobacco-producing counties. It is entirely possible that these reductions will operate through a multiplier effect to produce a downward spiral in the economies of these counties. If this is a realistic prospect, an additional set of questions must be considered. Will sufficient alternative employment opportunities be available in the region as workers are displaced from the tobacco industry? Do these displaced workers have the skills necessary to take advantage of these opportunities? If not, is job retraining a feasible alternative? If sufficient opportunities are not currently available, could industry be brought into the region to provide additional employment? What policies are needed to attract industry to the areas? If opportunities cannot be expanded in the region, what programs and policies are needed to help the displaced workers relocate in other areas? Most of the authors do not address these types of questions directly. This shortcoming is discussed by Don Paarlberg, whose main point is that the problem is more a *people* problem than a commodity problem. His judgment is that the assessments drawn from the conference would be different if the people-orientation to the problem had been taken rather than the commodity-orientation. I agree.

It is difficult to hold the individual authors responsible for the shortcomings of this volume. Some of this responsibility might be placed on the conference organizers, but most should be placed on the research institutions that deal with rural America. In this case, and in general, they have incorrectly identified the real problems facing rural America. Consequently, research on rural America deals with

only parts of the problem or misses the real problems altogether. The unfortunate outcome of this is that constructive rural development programs and policies, which depend so heavily on research for their conception and design, never see the light of day.

An excellent treatment of the problems that the tobacco industry will be facing during the 1970's is presented in this book. It should be a very useful volume for those interested in these problems and their solutions. However, it does not treat the regional adjustment problems which will accompany the changes in the tobacco industry during the next decade. Those interested in these problems and their solution will need to seek information elsewhere.

Lon Cesal

The Department of Agriculture

By Wayne D. Rasmussen and Gladys L. Baker. Praeger Publishers, Inc., 111 Fourth Avenue, New York, N. Y. 10003. 257 pages. 1972. $9.

Carving the Lord's Prayer on the head of a pin would be easy compared to describing the origin, growth, functions, and future of the U.S. Department of Agriculture, but in this little volume Wayne Rasmussen and Gladys Baker have accomplished the task most effectively. Both authors have spent their adult years working with eight Secretaries of Agriculture and their transitory personal staffs, with the larger number of more permanent Administrators, and with the 100,000 full-time employees to whom the book is dedicated. The authoritative narration of the Department's story reflects the authors' broad knowledge of the Department.

How do you describe such a multipartite governmental organism? The authors solved this problem by simply following, in large part, the pattern of the other 30 volumes put out by Praeger Publishers in their series, "Praeger Library of U.S. Government Departments and Agencies." There are chapters on The Old Department—1862 to 1932; The New Department—1933 to date; Organizing Agriculture (i.e. the USDA); nine on problem areas: and finally a look ahead. There are four appendices: "A" discusses briefly career opportunities in the Department; "B" gives sketches, averaging about 50 words, of the major agencies; "C" lists the Commissioners and Secretaries from Newton to Hardin; "D" records the Organic Act. The Bibliography lists the yearbooks since 1936, and selected books, papers, and speeches about Department problems and policies, but only three books about individual agencies. This is not an oversight, as "The Soil Conservation Service" by D. Harper Simms, "The Agricultural Research Service" by Ernest G. Moore, and "The Forest Service" by Michael Frome are the only recent books that have been written about the Department's agencies. Hopefully there will be others, as the need is great, especially since significant changes affecting the various agencies appear to be in the offing. Rasmussen and Baker included a few pages of pictures that fittingly enough begin with a picture of a "horse and buggy" county agent and end with the Secretary eating a school lunch with a biracial group of youngsters.

During the 70-year history of "The Old Department," the emphasis was on increasing production per man, per acre, and per animal. These highly successful efforts brought bountiful production in the 1920's but also the paradox of "a continuing farm depression in the midst of industrial prosperity." The authors conclude: "Clearly the Department could no longer confine itself to education and research. The farmer's economic position had become steadily less secure. By 1932, he was on the edge of revolt." The chapter on "The New Department" makes nostalgic reading for those of us who participated in the activities of the New Deal in agriculture inaugurated in 1933 by President Franklin D. Roosevelt and his young (45-year-old) Secretary of Agriculture, Henry A. Wallace. The Agricultural Adjustment Act of 1933 was intended to "relieve the existing national economic emergency" and contained three sections. "Title I dealt with Agricultural Adjustment; Title II was known as the Emergency Farm Mortgage Act; and Title III empowered the President to inflate currency." Control of production of corn, wheat, cotton, tobacco, and hogs received prompt attention. To relieve the critical oversupply of hogs, it was decided to "remove immediately from marketing channels approximately 4 million pigs weighing less than 100 pounds each and 1 million sows about to farrow." This drastic program brought a shocked reaction. Charles F. Sarle, a Department employee and long-time associate of the Secretary, told this reviewer that he had originated the idea of "killing the little pigs" and had "sold" the slaughter plan to the Secretary to whom it was abhorrent.

The Supreme Court ruled on January 6, 1936, that "AAA use of the proceeds of the processing tax constituted control of agricultural production, an unconstitutional invasion of rights reserved to the States." A new act was passed promptly but was

considered inadequate, and in 1938 another was passed which Wallace called the "ever-normal granary." The pattern of the new Department was set by the addition of many agencies and activities: Soil Conservation Service, Federal Surplus Commodities Corporation, Farm Security Administration, Federal Crop Insurance Corporation, Rural Electrification Administration, Farmer Cooperative Service, and the Commodity Credit Corporation. The Department was never to be the same again.

The 11 areas into which the remainder of the text is divided are themselves indicative of the ever-changing role of the Department: Organizing Agriculture; Research, Regulation, Education; Conservation and Land Use; Production Adjustment and Price Support; Rural Development; Ending Hunger in the Midst of Plenty; International Affairs; The Department of Agriculture and Other Government Departments; The Department and Congress; The Department at the Grass Roots; and What Lies Ahead for Agriculture? These, of necessity, are miniaturized expositions of complex programs, policies, and problems. However, the authors have been able to achieve in large measure their expressed goal of "presenting the Department as it is" from a sympathetic point of view. For example, they make it abundantly clear that a Department that had done a masterful job helping farmers to produce more and had been reasonably successful in production control and marketing had suffered severely in socioeconomic problems. "The attack on rural poverty . . . was grandly conceived and articulated. It was not so grandly executed." Writing in the fall of 1971, the authors thought "the most substantial contributions were made by agencies that had been established in earlier years—the Farmers Home Administration, Forest Service, Rural Electrification Administration, Farmer Cooperative Service, and the Extension Service."

The chapter "Ending Hunger in the Midst of Plenty" should be read and studied by anyone more than passively interested in the vexing problems of providing an adequate diet for all. Efforts to dispose of surplus commodities in the 1930's brought about the "direct distribution, school lunch, school milk, low-cost milk, and food stamp programs," but Department officials and some of their supporters in Congress believed that "welfare and relief programs were not the Department's responsibilities," so action was limited. By the late sixties, attitudes had changed both in the Department and in Congress. In 1968, the "poor people" picketed the Department and action resulted. "With the advent of the Nixon Administration in 1969, the Department expanded its food assistance programs. . . . The number of needy children receiving free or reduced-price meals at school increased from 3.8 million in May 1969 to 6 million in February 1971. The number of counties and independent cities lacking a family food program for poor people was reduced in this period from 436 to 10." However, "much more needs to be done."

We are reminded that relations between the Department and Congress are changing in response to the sharp decrease in the farm population—now about 5 percent of the total population. Membership on Agricultural Committees is no longer "eagerly sought."

The Department's relations with the farm organizations, land grant colleges and universities, State departments of agriculture, trade associations, advisory groups, and the general public, especially at the grass roots level, underscore the close communion the Department has established and maintained with those concerned with agriculture. It is a source of great strength, although sometimes troublesome, to the Department.

Human-interest incidents and internecine strife appear only as trace elements like this parenthetical insert in a sentence relating how Franklin D. Roosevelt resolved the fierce battle between Henry Wallace and the "Old Curmudgeon" (Harold Ickes) as to whether the Soil Conservation Service was to continue in Interior or be transferred to Agriculture: "Despite the opposition of Secretary of the Interior Harold Ickes, President Roosevelt (while Ickes was vacationing in Florida) ordered the change."

On January 22, 1971, President Nixon presented a reorganization plan which to some startled agriculturists seemed to mean that the Department was to be drawn and quartered with the various members submerged in four super-amalgams. This prospective demise of the Department is duly recorded by the authors, but at the last minute came a reprieve that is announced in a postscript on the final page of the text which states in part: "On November 11, 1971, as this volume was going to press, President Richard M. Nixon announced he had concluded that it was necessary to have a separate Department of Agriculture." However, the authors' conclusion that the "future of the Department and its programs is in question" still seems pertinent.

"The Department of Agriculture" is an excellent and important book and a landmark, as patently the USDA is to be altered, perhaps sharply, in scope, functions, and goals. The book tells you all you need to know about the Department unless you are seeking knowledge in depth of a specific agency.

Emerson M. Brooks

The Reluctant Farmer: The Rise of Agricultural Extension to 1914

By Roy V. Scott. University of Illinois Press, Urbana, Ill. 61801. 362 pages. 1972. $8.95.

At first glance, the reader may find difficulty in comprehending the relationship between the title and the subtitle of this book. Actually, the subtitle gives a better inkling of its contents.

Roy V. Scott, professor of history at Mississippi State University, has done an extensive research job of documenting the rise of agricultural extension education in the United States from about 1780 to 1914. Particularly commendable is the effectiveness with which he used available data.

He relates by individual States the progress of agricultural education, through the agency of regional fairs, college courses, model farms, and crop-improvement programs, to the emergence of the county agricultural agent. This step-by-step procedure was no small undertaking and not without a formidable obstacle: The apathy of the farmers to innovations or change. This is the meaning of the title.

In fairness, however, it should be noted that the reluctance of farmers to use improved farming devices and methods was not due exclusively to ignorance and inertia. The farmers believed that new techniques would be unnecessary since there was ample inexpensive and fertile land available.

What marked the end of an era and the beginning of the new age of agriculture was the enactment in 1914 of the Smith-Lever Act. This measure enabled the Federal Government to assume a major role in extension work and coordinate the varied efforts to improve farm productivity in a direct way.

Although this book is not a definitive work, it certainly is one of the best on its subject published to date.

Jack Ben-Rubin

The Growth Potential of the Japanese Economy

By Kenneth K. Kurihara. The Johns Hopkins Press, Baltimore, Md. 21218. 148 pages. 1971. $7.50.

It is those classicists who believe that abundant natural resources are a sine qua non of economic development and those dogmatists who feel that a capitalist economy cannot grow without colonial exploitation who are most ready to characterize the Japanese postwar experience as a miracle. But miracle or not, the experience can be explained in terms of Japan's national peculiarities. It is in this perspective that Kurihara analyzes what he consideres to be the fundamental forces governing the speed and pattern of Japanese economic growth.

Japan's growth controversy centers on the nature of the obstacles to growth, principal among which is a chronic shortage of labor. This may come as a surprise to those readers who heard only yesterday of Japan's overpopulation and cheap labor, but a continuing shortage of labor is the rule rather than the exception in the Japanese economy of today. Kurihara hypothesized that there would be a negative rate of change in the manpower coefficient (the ratio of labor to population) during the income-doubling decade of the sixties. Data which are now available show that the rate of change was positive but the slow rate of population growth (1 percent per year) is itself a presumption against there being sufficient labor to man a growing stock of capital. On the demand side, Kurihara built his model around a projected average annual rate of growth of total employment of 1.2 percent. It turns out that the rate was actually 1.4 percent (from 1955 through 1970), further exacerbating the situation and leaving the Japanese economy of tomorrow with no margin of safety in the form of labor reserves. The rate of growth of the labor force was also 1.4 percent. At the same time, the employment structure moved toward the more labor-intensive services at a slower rate than Kurihara used (3.3 percent versus 5.8 percent), but the decrease in agricultural employment was greater than predicted (-4.1 percent versus -2.8 percent). "This drastic decline in the agricultural sector represents the relentless operation of the law of diminishing returns that cannot, because of the geographical and institutional nature of the Japanese case, be readily counterbalanced by technological innovations. As in other advanced industrial economies, the agricultural sector, both as a contributor to total employment and as a supplier of foodstuffs and raw materials, is rapidly becoming a marginal industry which could hardly survive without the government's farm support policy or its protectionist measures against competitive imports."

Another obstacle to further economic growth, at least in the view of many economists, is social overhead capital formation. Kurihara takes exception to this orthodox standpoint of resource allocation whereby it is assumed that Japan's total resources will remain constant even in the long run, although new resources may well be discovered, invented, or

imported. "In view of such dynamic technological and international possibilities, it would be a serious mistake to adhere to the static, conventional idea that social overhead capital cannot be augmented except by limiting the resources available to private capital goods industries." Kurihara feels that social overhead capital formation not only generates demand but has a salutary influence on general labor productivity as well and is therefore not a quid pro quo for further growth but actually contributes to capacity expansion.

Kurihara believes that most of the conditions favorable to continued economic growth in Japan are indefinitely sustainable and that most of the weak spots are remediable. His book is a useful addition to the international growth policy debate in general and the Japanese growth controversy in particular.

Bruce Greenshields

Farming in the New Nation: Interpreting American Agriculture, 1790-1840

Edited by Darwin P. Kelsey. 233 pages. Agricultural History Society, Room 144, 500 12th Street, S.W., Washington, D.C. 20250. 1972. $5.

ERS was one of the sponsors of the Symposium at Old Sturbridge Village, which resulted in this volume. It is made up of a series of essays on aspects of American agriculture, 1790-1840. One is devoted to the economic and statistical analysis of the problems of the period.

Oxford Economic Atlas of the World

By the Cartographic Department of the Clarendon Press. Oxford University Press, 200 Madison Avenue, New York, N.Y. 10016. 239 pages. 1972. $25.

The fourth edition of this well-known Atlas adds many details not found in previous editions. The statistical supplement presents data comparing 1963-65 and 1953-55 for each country in the world.

Agricultural Origins and Dispersals: The Domestication of Animals and Foodstuffs

By Carl O. Sauer. The M.I.T. Press, 28 Carlton Street, Building E-32. Cambridge, Mass. 02142. 175 pages. 1972. $1.95.

The second edition of this well-known book contains three additional articles, dealing with plant domestication in the new world and the introduction of maize into Europe.

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